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Engineering News-Record

DEFINITE data concerning any condition under which excavation is made and pipe is laid, with resulting rational design, are given in G. C. D. Lenth's article on

Relation of Sewer Trench Width to Load on Pipe

SOME vivid impressions of a land where "every house is its own water-works and building stone is cut with hand saws," are set forth by E. J. Mehren in

Engineering Impressions of Bermuda

HOW remarkable speed was attained with all requisite safety in the construction of two 16-story apartment buildings in Chicago is explained in

Large Concrete Flat Buildings Erected in Thirteen Weeks

SOME interesting observations on formation of gelatinous coating or organic incrustation around sand grains are made by John R. Baylis in

Sand Bed Studies at Montebello Water Filters, Baltimore

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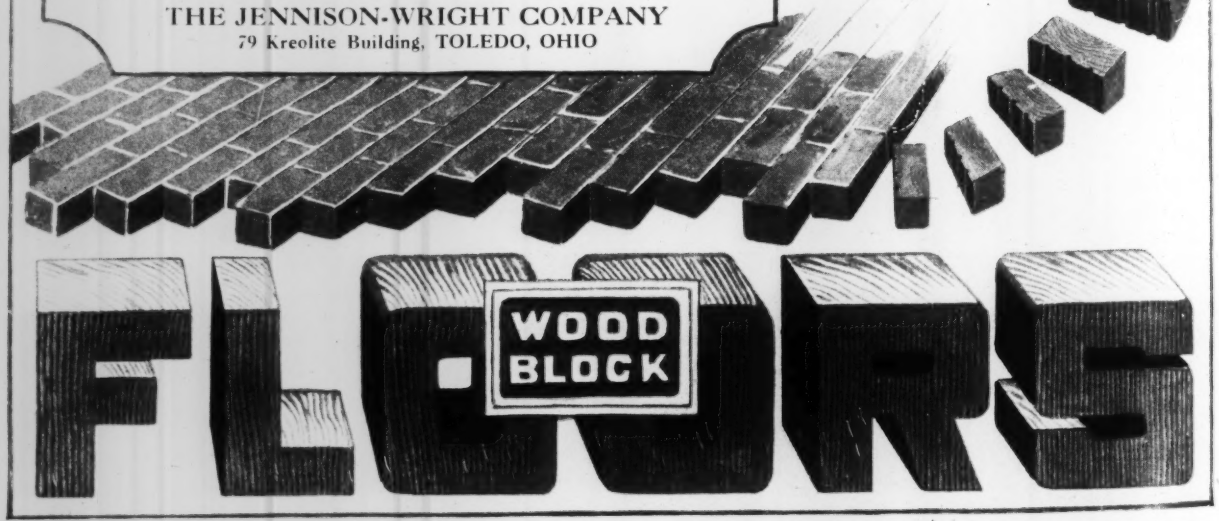

FLOORS

WOOD BLOCK

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 92 NEW YORK, MARCH 27, 1924 Number 13

Still a Mystery

THOSE who really want to know whether the Hydro-Electric Power Commission of Ontario is a socialistic monster or a successful trust buster are not going to be much informed by the announced part of the Gregory commission investigation. The report itself, it is said, fills ten or eleven motor trucks; all that has been made public is the Ontario premier's own interpretation of the conclusions of the inquiry. From the abstract of that interpretation given in our news pages, it will be seen that, at least in the opinion of the premier, the Gregory commission, which included one of the most capable engineers in the Dominion, is favorably disposed to the principles and operation of state owned power in Ontario and fails to see in it any of the horrible violations of economic law that marked the Murray report of a few years ago. The latest investigation does find extravagance and waste in the Chippawa construction but, as reported, the total amounts of this extra cost would not throw the whole enterprise from a practicable into an impracticable development. The net result of the information so far permitted to flow from the report is that the critics of Hydro have not been made any too happy. On the other hand, the unprejudiced students of the economics of government and of power are not much better off than before.

A Contemporary Passes

IN THE preoccupations of the new year a happening in the humble circle of house organs may have gone unnoticed by engineers who normally would wish to give it at least a moment's regretful thought. The *Miami Conservancy Bulletin* ceased publication with its December issue, as the reason for its existence has disappeared. The flood-protection works of the rich valley that slopes down from the Loramie reservoir in Western Ohio through the busy cities of Piqua, Troy, Dayton, Middletown, and Hamilton to the Ohio River are completed. The remarkable body of men who built the works and whom the little paper helped to bond together is dispersed, and only a maintenance force remains. In its four volumes the *Bulletin* has given worthy representation to the enterprise it served, and has matched the excellence and sharply marked character of the works with corresponding journalistic excellence and character. It gave newsy news of its field; it told the news promptly and clearly; avoiding flourishes, it made its story effective and engaged the reader's interest in the picturesque field operations; and in aggregate effect it set forth a faithful, life-like portrayal of the whole undertaking. The spirit that animated the district organization spoke out of its printed page. In the valedictory number the unknown editor writes, with the same quiet simplicity that marked the history of the Conservancy work, "This is the concluding issue of the Bulletin. . . . It is hoped that the aim of the bulletin has been attained; that its readers have gained from its pages a clear, intelligible picture of the manner in which the works have been constructed."

Motor-Vehicle Tax Income

STATE income from motor vehicle taxation increased over 37 per cent in 1923 according to statistics collected by the Bureau of Public Roads. The number of motor vehicles registered increased from 12,238,375 in 1922 to 15,092,177 in 1923. In 1923 motor-vehicle owners paid the states in registration fees and gasoline taxes $225,784,931, of which about two-tenths were receipts from the tax on gasoline in 35 states. All states now require registration of motor vehicles and all but 13 tax the fuel used in motor vehicles. The significance of these figures to engineers and contractors is that virtually all of the money is spent on highway improvement and is almost one-fourth of the total annual highway expenditure. In the present preliminary announcement the Bureau of Public Roads does not segregate the income from registration fees according to type of vehicle nor indicate the distribution of income. Probably, however, the percentages are not far different from those we have for 1922. In that year about 77 per cent of the income from registration fees and about 54 per cent of that from gasoline taxes were applied to state road work. Of the remaining amount all, except in a few states, goes to the counties for county construction and maintenance.

No Progress on Colorado

IT IS not clear just what the army engineers and reclamation engineers who have just reported on the Colorado River problem really recommend. They express certain abstract conclusions, but none that can be called a recommendation. Apparently they recommend nothing. This is hardly a satisfying response to the necessities which led to the creation of the Select Board. Nothing in the West is more urgent than constructive action on the Colorado, and indeed no public-works question in the United States approaches it in immediate importance. Before anything can be done, the right thing to do must be determined; and this, it was expected, the Select Board would do. It fails to do this very thing, however. It reports that a dam at Boulder Canyon will be desirable, some time or other, before or after some other dam enterprise, but it does not report that this dam should be built first, or be built now, or that anything else be done now. Such a result is dissappointing. It does not advance the status of the problem. Congress should either refer the report back to the Board with the demand that tangible recommendations be reported, or it should appoint a new board for the purpose. There is no necessary reason why differences of opinion between army and civilian engineers cannot be harmonized.

Conclusions From Highway Traffic Surveys

A HIGHWAY traffic analysis unequalled in breadth and detail is presented in this issue. It is based on the Connecticut and California traffic surveys, the findings of which are here for the first time announced in a somewhat definitive form. These data have been so long awaited and are so well worth consideration that they justify the exceptional amount of space which they have been given. It is not likely, moreover, that transport engineering will have more complete information until the Pennsylvania survey, now just begun in a more nearly perfected and comprehensive manner, is completed. Thus the conclusions arrived at are now the best and for some time will remain the best by which we can lay down general principles of highway traffic management.

After the authoritative statement by Professor McKay it is almost supererogation to attempt further discussion. There is good reason, however, for emphasizing his statement of the practical utility of traffic surveys. They are still regarded by too many as a refinement of the technician having little bearing on the most practical task of the highway engineer—to pull his roads out of the mud so that they may be twelve-months-a-year thoroughfares. It is an error to assume the traffic survey to be of no value even in the primitive situations, but its greatest value naturally is where industry has developed and population is dense. There a knowledge of traffic character and conditions and trends is a prerequisite to even approximately intelligent engineering planning of road improvement.

There is another point to be noted and that the article and charts bring out only indirectly; this is that a traffic survey must be for more than a traffic census. Merely counting the vehicles which travel the roads falls far short of telling the road engineer all that he needs to know of road traffic to design and build scientifically and do his system planning intelligently. It is worth while to glance over the charts to observe the variety of information secured in the Connecticut and California surveys. And who would presume to say that any of these data are useless or even of secondary importance, compared with the count of vehicles. Indeed were the other information, as weight, speed, overload, origin, destination and classification, possible without a count it would not matter greatly if the number if vehicles was never known. In saying this there is no disposition to condemn the traffic census. Often it is all that the means at hand will permit and often it is all that at the beginning is needed to meet the situation. The purpose in mind is to make plain that the traffic survey is a high development compared with the vehicle census which has commonly been our only effort, until recently, to study highway traffic.

Among the things which Professor McKay develops from his chart records, are, it will be noted with interest, four conclusions as to the economic fields of motor truck transportation. Their reasonableness allows very little opportunity for criticism even by those having at heart first the interests of the railways. Indeed the first two are measures of direct economic aid to the railways. Long-haul traffic is, it will be noted, virtually eliminated as a field for economic motor-truck service.

From the records obtained, so far as they are indicated by Professor McKay, the desirability of the extension of traffic surveys seems plain. In both the Connecticut and the California surveys the Bureau of Public Roads has joined financially and by giving technical aid and it is now similarly aiding the Pennsylvania survey. It will work with other states who desire to undertake traffic and transport studies. It has a plan of co-operation which promises benefit in getting comparable data and eliminating waste motion.

Arch Dam Tests

THE first failure of a simple arch dam has yet to be recorded. This fact has been the subject of much speculation but the various opinions advanced have had one point in common, namely, the inescapable conclusion that arch dams as ordinarily built have a large factor of safety—large enough to cover all deficiencies in design, materials or construction that may have occurred in any structure of this type thus far put in service. This is the point to the whole matter. If there were less uncertainty as to just how stresses are carried in arch dams and how such structures act under varying conditions of load, materials and temperature, it would be possible to design more economically and still provide ample safety, that is to say the designer could then consider safety factor and economy together and strike a balance consistent with the requirements of any given case. It might even be that with the lower cost in a design that would fully and effectively utilize the strength of materials employed, arch dams so built would be feasible where development is now too costly.

Engineering Foundation now has under way a very important investigation of this subject which is attracting particular interest since the committee in charge is making preparations to build a full-scale test dam with facilities and equipment for measuring distortion and determining stresses. Later the dam is to be loaded to destruction if possible. As noted elsewhere in this issue, this work will begin as soon as subscriptions to cover the cost of the proposed tests have been received. These should not be long in forthcoming. Research that promises to shed new and helpful light on this subject should command the interest of all who have to do with dam construction. With a dam built expressly for research purposes at a site where no danger would attend its sudden destruction, and with tests carried on by an unbiased committee of engineers working without compensation under the direction of one of the nation's leading research organizations, there is afforded an excellent opportunity for the co-operation of the many interests and organizations that stand to benefit from more detailed knowledge of stresses in arch dams.

Small dams in this country continue to be designed and built with the most reckless disregard of engineering principles but instances of incompetency in the design or construction of important dams are becoming rare. The improper design and lack of technical supervision that appeared to have caused the Gleno dam failure in Italy could hardly have occurred here. Under our present system of state supervision in most of the states and with past experiences to make capital wary of irresponsible designers, proper design and adequate inspection at least may be expected to obtain in all cases where life and property are involved. Where there is thus every facility for accurate design and skillful supervision of construction, and where so much water power development is contemplated, there is urgent need for more information on arch dams and it is most

desirable that the proposed tests be carried out as promptly as possible. In fact it is to be hoped that the Engineering Foundation committee will continue its work beyond the present study of the simple arch. The constant angle arch, various types of multiple arches and other variations of arch dam design await study and analyses and it would be a long stride forward to have such analyses made by a committee whose findings would doubtless carry weight with state engineering departments and commissions.

Loads on Sewer Pipe

ALLOWABLE minimum and maximum depths of filling material over sewer pipe, maximum widths of trench for given sizes of sewers and methods to insure safe and permanent construction have now been determined with sufficient accuracy to eliminate most of the failures which have long haunted the sewer designer and contractor. Although great strides have been made in the study of the strength of material only recently has any considerable thought been given to the bearing power of soils, so far as it pertains to trench work. The article by Mr. Lenth in this issue is a step forward toward more accurate sewer designing.

As a result of long series of experiments there have been prepared by the various manufacturers' tables of the safe-working strengths for each shape and size of ordinary structural units and this data is now considered as standard by the engineering profession. But when we turn to the art of sewer construction we find very little if anything has been done. Many engineers still believe that a 12-in. sewer pipe should sustain the load due to the depth of cover varying from 2 ft. to 25 ft. when laid in a ditch varying in width from the exact outside dimensions of the pipe to widths as high as two and three times the internal diameter of the pipe.

There are two approaches to this question—the one, the manufacturer aided by the ceramist investigating the raw material and the fabrication problem and the other the testing engineer and physicist. In the first group may be placed such research work as is conducted at Mellon Institute of Industrial Research, University of Pittsburgh, under the direction of H. G. Schurecht, a national authority on ceramics and clays. By means of chemical and microscopic analysis, clays are grouped as to their value for the purpose of manufacture of sewer pipe and drain tile. This study has led to investigation into the proper grinding of clays, the fineness to which they should be ground before being tempered, the removal of iron in the form of pyrites, siderite, marcasite and limonite, using magnetic separators to insure elimination of these impurities so that when the sewer pipe reaches the final stage of vitrification it readily takes a smooth salt glaze. All of this research involves work of a highly technical character and leads to many ramifications in the study of plant machinery and kilns. While these studies have been most necessary, unless coupled with the work of the testing engineer and physicist they would not result in the most efficient solution of the problem. In the latter group are the Iowa tests by Dean Marston, on which Mr. Lenth's calculations are based.

It is with a view of creating an interest in the art of proper sewer construction and a step toward standardizing this practice that the article by Mr. Lenth was prepared. When sewer design attains more of the constants and less guesswork more city engineers will sleep with an easier conscience.

Sand for Filter Beds

LIKE the pupil of Agassiz, the delver after facts relating to filter sands seems never to reach the end of new and useful information. In this issue a new study is presented, although nothing new seemed possible after the symposium in *Engineering News-Record*, Nov. 11, 1920, p. 934, and the previous discussion on under-water shrinkage by Wolman and Powell.

Probably the inventors of the old mechanical rake systems and the strenuous advocates of air washes may well be listened to again for a time. They had the same problems of dirty top sand, and solved them, but the advent of rectangular tanks and the heavy initial and operating expense of the air installations led to the high-velocity wash with deep gravel underdrains which seemed to solve the operator's difficulties. Nevertheless, here and there over the country operators began to complain that the high velocity did not clean the sand at least during certain periods of the year. Louisville has had trouble every year. Denver has had trouble with top surface clogging, mudballs and probably cracking for more than twenty-five years but the wash rate is extremely low. The experiments at Oakland, Calif., on an algæ-infested lake water indicated that even a 3-ft. vertical rise of wash water would not remove the sticky gelatinous organic material from the sand at the surface. Last year the new plant at Winnetka, Ill., had trouble from short runs. So have the plants on Lake Michigan south of Chicago at Whiting and East Chicago. Short runs in the algæ season are the bane of the operator's life. The Oakland experiments with a top-sand washing grid were only fairly initiated when the panic of 1907-8 removed financial support. However, the idea seems to have been kept alive by an installation at the Champaign-Urbana Water Co. on an iron-removal plant in successful operation in 1915 and a few succeeding years until the use of chlorine prevented the crenothrix growths.

A novel arrangement designed to wash the surface sand was developed by C. Arthur Brown at Tulsa, Okla., in the way of V-shaped baffles placed in the beds just above the sand level at rest. The V was open at the bottom and when the sand rose under washing conditions was forced at a rapid note through the slots between adjacent Vs at the top edges. Mr. Brown has made further studies on a plant in Pennsylvania to determine desirable slot opening, baffle slopes and width. His results, if they accomplish the purpose, will provide still another method of sand-surface scrubbing which practically all of these investigators conclude must be accomplished in some way. Since it is of stationary construction and requires no additional air or water it should be the least expensive of any method proposed.

With all the new plants under way or about to go into service to treat waters sure to produce organic growths on the sand grains, designers and prospective operators should read Mr. Baylis' experiences with a view to their own profit. When the 24-hour runs suddenly drop to a 4-hour period it is too late that season to do more than curse and "sit on the lid" and, like a hay fever addict, pray for cold weather.

Sand-Bed Studies at Montebello Water Filters, Baltimo[illegible]—I

Observation of Individual Sand Grains with Camera Lucida Discloses Gelatinous Coating the Thickness of Which Affects Efficiencies—Jet Action from Perforated Pipes near Surface Controls Films

By John R. Baylis
Principal Sanitary Chemist, Montebello Filters, Baltimore, Md.

CRACKS, mud balls and clogged places in the thirty-two filter beds of the Montebello plant, Baltimore water-works, are attributed largely to the loose settling of the beds after washing and to their subsequent settlement while filtering. An excessive gelatinous coating around the sand grains causes the loose settling. After several years of close physical and microscopic observation of the sand and experiments in the operation of the filters it has been found that the removal of a portion of the gelatinous coating by direct jet action of wash-water applied through perforated pipes near the sand surface will maintain the beds in a satisfactory condition summer and winter. Due to the excess of gelatinous film a larger sand grain is preferable in

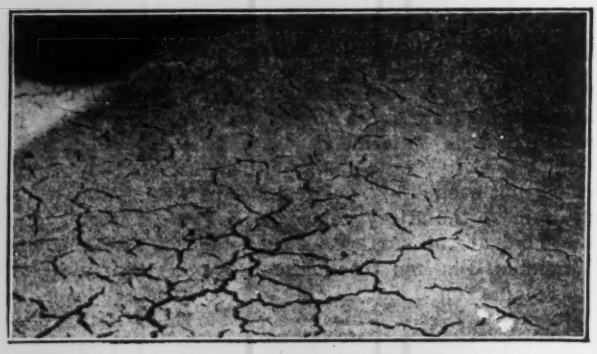


FIG. 1—SAND SURFACE CRACKS IN MONTEBELLO FILTER BEDS

This condition occurs every spring and fall in all the beds. Occasionally not a square inch is free from cracks.

summer but in winter the film grows less vigorously and a smaller grain is desirable. A happy mean is required which at Baltimore has been found to be about 0.6 mm. The size, composition and other characteristics of the grains have little influence on the thickness of coating formed if there is no force tending to remove it, but the size has great effect on the settlement that will take place, and, due to abrasion in washing, greatly affects the amount of coating that will be retained on the grains. The remedy for such troubles as the pulling away of the beds from the side walls, the formation of cracks and clogged places and bacterial growths, when the proper size sand has been used, is to prevent the formation of an excessively thick gelatinous coating or organic incrustation around the sand grains.

Early Experiences—The sand originally placed in the beds in 1915 was quite variable in size, and when it had hydraulically graded itself the depths of different sizes varied considerably. Iron and lime were first used as a coagulant, and soon the grains were so incrusted with carbonate of lime that there was no need of removing the former very fine grains from the surface. The beds kept increasing in depth as the incrustation became thicker, until the sand surfaces were only 10 or 12 in. below the top of the wash-water troughs. The rate of wash was gradually reduced in trying to prevent the loss of sand, until the vertical rise was only about 14 to 16 in. per minute. The wash at this rate without the use of air was not sufficient to agitate the beds properly and prevent the formation of many clogged places, even in the absence of a gelatinous coating around the grains. These clogged places were caused partly by suspended matter entering through the cracks along the side walls, and partly by the cementing effect of the carbonate of lime depositing on the sand grains. Since shortly after the plant was put in operation, in 1915, there has been a pulling away of the beds from the side walls of the filters. Frequently cracks 1½ in. wide at the sand surface would extend nearly to the gravel. Numerous clogged places formed around the side wall. The sand grains became so incrusted with lime by the end of the second year's operation that the smallest grains (0.7 mm. diam.) were larger than the sizes essential for efficient filtration in the colder months when iron was used as a coagulant. Ineffectual attempts were made to break up these clogged places as soon as they formed. The rate of wash was increased to about 27 in. vertical rise per minute, which helped some, but soon about 4 in. of the sand was washed away. The top 8 in. being about the same size, due to the incrustation, the part washed away was not all of the originally finest sand, but a mixture of all the finer sizes.

In the early part of 1918, alum was used as a coagulant part of the time and greatly reduced the incrustations, due to the free carbonic acid dissolving the carbonate of lime. Clogged places continued to form, especially around the side walls. A sand-washing machine, consisting of an ejector and a Nichols sand separator, was put in service in 1918. Sand from all the beds was run through this machine, which broke up the clogged masses and removed a little of the incrustation from the grains. The settlement of the beds and the pulling away from the side walls was greatly re-

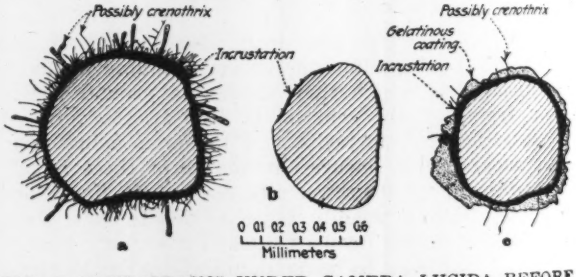


FIG. 2—SAND GRAINS UNDER CAMERA LUCIDA BEFORE AND AFTER INSTALLATION OF WASHING JETS

In the part of Filter 2 without jets the sand grains had an incrustation about 20 microns thick (2a) from which were growing numerous filamentous bacteria. The gelatinous coating (2c) which gets excessive in September and October, dies after a few weeks and is easily removed by ordinary washing. During this excessive growth period the filamentous organisms are apparently killed. The incrustation is a permanent growth much harder than the temporary outside growth. However, much of it can be removed by surface jet action as noted in 2b, which is from a portion of Filter 2 in which jets had been operating for five months. This sample was taken at the same time as 2a.

duced for a short time, but within a few months conditions were as bad as ever. Alum was used as a coagulant most of the time in 1919, and by July of that year practically all incrustations caused from the lime and iron treatment had been removed. In the fall of 1918, many small cracks, such as are shown in Fig. 1, opened in all parts of the sand surface on all the beds. Hardly a square inch of surface was without a crack in some of the beds with the finer sand. These cracks have occurred at certain times in the spring and fall every year since then. They may have occurred earlier, but there is no positive record of an earlier occurrence.

Coating Around the Sand Grains—Since the removal of the lime incrustation a gelatinous coating or organic incrustation has formed around the sand grains, which at times is more than 0.05 mm. in thickness. This is not a condition peculiar to this plant only, for observations made on sand from the beds of other plants where alum is used as a coagulant have always shown the presence of coating after several years.

What is this coating, and what causes it to form? Does it merely adhere to the sand grains, or does it adhere to any surface? The author has been unable to find any surface, not exposed to the direct rays of the sun, from the beginning of the tunnel at the Loch Raven reservoir to the point where chlorine is applied at the Montebello filters, that does not have a gelatinous coating on it part if not all of the time. Surfaces of the rock in the tunnel, concrete conduits, wood, paints of different composition on wood or iron, glass, rubber, copper, lead, limestone, sandstone, quartz and in fact any hard surfaces examined have shown the presence of this coating when in contact with the water which is not flowing at a high velocity. Every surface in contact with the water after filtration and before the chlorine is applied has this slimy coating most of the time. On surfaces other than the sand grains it is usually much thicker and not so hard, but this can be

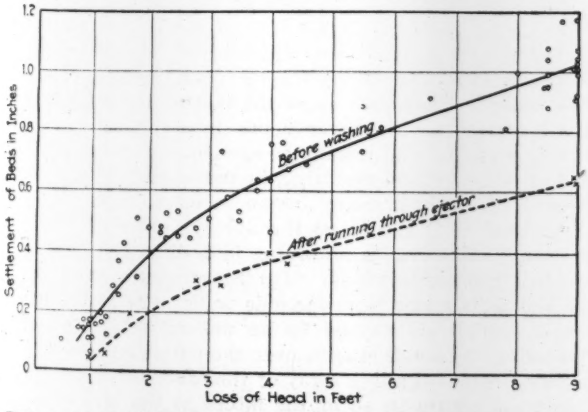


FIG. 3—CLOSE RELATION BETWEEN LOSS OF HEAD AND FILTER BED SETTLEMENT

explained by the fine silt and other hard substances in suspension in the water helping form a more compact mass—possibly pounded into the gelatinous coating while washing, somewhat like pounding stones into soft mud to form a hard surface. Chemical analysis of the coating around the sand grains, given in Table I, shows the organic matter and manganese to be in greater proportion than is found in the suspended matter going on to the filters.

Chemical analyses of the coating on surfaces before the alum is applied, and also after the water has been filtered, show the organic matter present in large amounts. It is surprising how quickly this coating will form at times in the warmer months. Sometimes only two or three days are required for the coating to form several microns in thickness, and the surface to have a slimy feeling.

Fig. 2a shows a section of a typical sand grain from

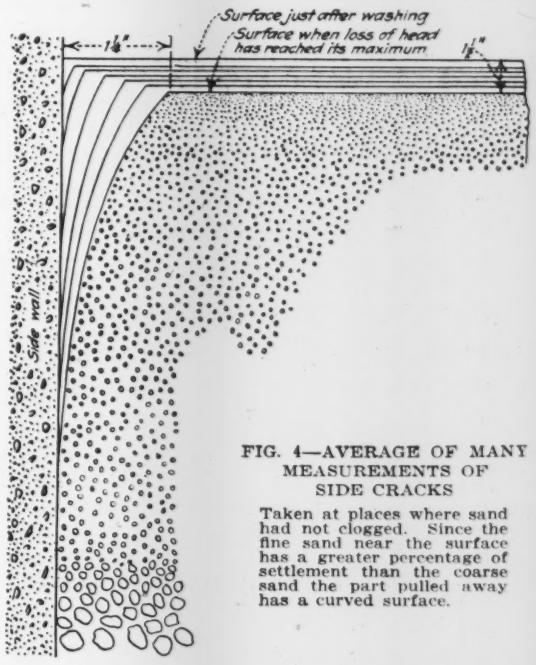


FIG. 4—AVERAGE OF MANY MEASUREMENTS OF SIDE CRACKS

Taken at places where sand had not clogged. Since the fine sand near the surface has a greater percentage of settlement than the coarse sand the part pulled away has a curved surface.

near the surface of one of the filter beds. Numerous filamentous bacteria, probably some species of schizomycetes, were growing at this time in the gelatinous coating on all of the grains in all the beds. This is an actual camera lucida drawing of a grain, in which the outline of the coating and the filamentous bacteria were traced, then the coating sufficiently dissolved with acid so that the outline of the grain could be drawn. A number of drawings were made of grains from vari-

TABLE I—MINERAL ANALYSIS OF THE GELATINOUS COATING AROUND THE SAND GRAINS

	Per Cent
Organic matter	20.0
Calcium oxide	0.3
Magnesium dioxide	Trace
Insoluble	25.0
Iron and aluminum oxide	46.5
Manganese dioxide	3.8
Sulphates	0.4

ous beds. The one shown is about an average of what was found. The thickest coating is usually found on the smaller grains. These filamentous bacteria are by no means the only ones growing in the gelatinous coating, and are possibly not of constant occurrence. There is evidence of considerable biological action taking place in the beds in the warmer months. Table 2 shows the amount of the dissolved oxygen adsorbed from the water in passing through the beds in the summer of 1922. These results have been confirmed in 1923.

At the time these tests were made there was a loss of 1.4 p.p.m. dissolved oxygen at approximately the rated capacity of the filters, and nearly all was adsorbed when the rate was cut down to about one-eighth rated

capacity. Routine bi-weekly tests on the raw and filtered water show the dissolved oxygen to be about the same in both, for the winter months, and about 1.5 p.p.m. higher in the raw water than in the filter effluent in the summer months. The fact that there is a greater reduction when the rate of filtration is decreased, and that there have never been any gases liberated in the beds, is conclusive proof that the oxygen is being consumed in the bed. If this is a fact the carbonic acid should be increased, which was found to be the case.

Settlement of the Filter Beds—Sand placed in the filter beds at the Montebello filters will soon become coated with a gelatinous film which gradually hardens to what might be called an organic incrustation. This material may increase the volume of the grains nearly 40 per cent for fine sand below 0.5 mm. diameter. This considerably reduces its specific gravity. When the filters are washed the sand settles back loosely, due partly to adhesion of the coating, which will stick to another grain as soon as it comes in contact with it, and to the coating having a rougher surface than that of the sand grains. Surfaces of one grain will not have a tendency to slide on those of another in arranging themselves in the bed. Measuring several beds that were allowed to stand full of water 24 hours after washing, without filtering, showed a settlement of only ⅛ in. The sand with the thickest gelatinous coating is usually near the surface, so the sand that will settle the most under pressure is located where there is very little pressure on it when not filtering.

To determine how much settlement was taking place in the beds, about twenty of them were measured. A

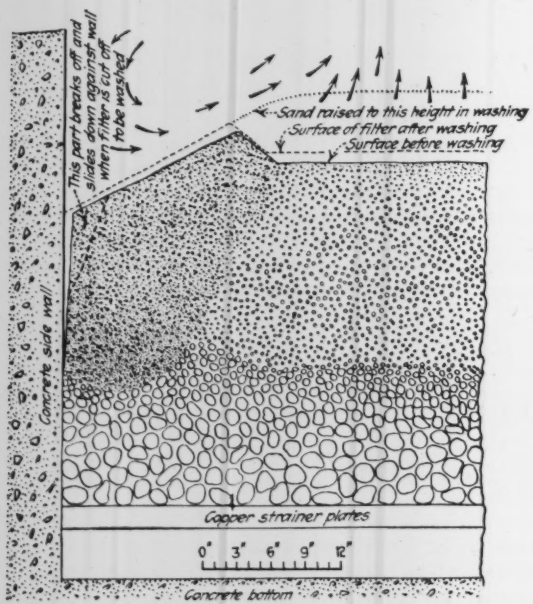


FIG. 5—CLOGGED PLACE ALONG SIDE WALL DUE TO SUSPENDED MATTER NOT BROKEN UP BY WASH

This drawing represents an average of clogging around the side walls of all the filters at the Montebello plant in the warmer months.

wooden cross made of boards 6 in. wide and 2 ft. long and having a rod extending above the water surface, was used. After the filters had been washed and were ready to be put in service the measuring device, which was just heavy enough to sink, was carefully lowered to the sand surface in the center of the bed, and pressed down ¼ in., so as to make it come firmly in contact with the sand over its entire bottom. A measurement was made, the filter put in service, and when it had reached its proper rate of filtration in about 20 min. another measurement was made. Others were then made every few hours until the loss of head reached its maximum. Fig. 3 shows plotting of these measurements. The

FIG. 6—CLOGGED MASSES RAISED ABOVE SURFACE

This extreme clogging in one of the filters in September, 1922, occurred when the sand grains had a heavy gelatinous coating.

close relationship existing between the loss of head and the settlement taking place is notable. When the settlement deviates from the average it can, in most instances, be accounted for in a difference in the depth of bed or size of sand.

Three Kinds of Cracks—Settlement is obviously the direct cause of the formation of cracks, for they could not form if there were no shrinkage of the beds. These cracks greatly aid in the formation of clogged places,

TABLE II—AMOUNT OF DISSOLVED OXYGEN ADSORBED FROM THE WATER IN PASSING THROUGH THE FILTER BEDS

Number of Tests	Dissolved Oxygen—Before Filtration	Dissolved Oxygen—After Filtration	Rate of Filtration M. G. D.	Loss of Head Ft.
25	3.2	1.8	4.2	4.3
10	3.9	0.3	0.5	0.5

being directly responsible for the clogging around the side walls. They also allow the matter in suspension to be carried to a greater depth into the bed before filtration starts, and usually to sand much coarser than that in the surface, resulting in the suspended matter passing the beds in many instances where it would be filtered out if it had to go through the entire depth of the sand. The cracks occurring in a filter bed may be divided into three kinds: (1) Side cracks, in which the bed pulls away from the side walls; (2) settlement cracks, which are caused by an uneven settlement of the beds; (3) small cracks, over the entire surface.

Side Cracks—Pulling away of the sand beds from the side walls occurs in all of the filters at the Montebello plant, and in the filters of practically all plants using a background flow of water for washing. In some plants this pulling away is very little and is possibly not detected, but in others it is very noticeable. It is not uncommon to see the sand beds at their surface pulled away from the side walls in the Montebello plant fully 1½ in. in filters having a total depth of sand less than 24 in. These side cracks are the ones that give nearly all the troubles from side clogging, and the fact that they occur at all times and under all conditions makes them of greater importance than any other kind. The cause can be attributed to the loose settling of the

sand after washing, and not to a highly adsorptive sand, as has been suggested. Any filter having a settlement of ½ in. or more will pull away from the side walls or from any vertical surface in the bed. The greater the settlement the wider will be the crack at the surface of the bed but it has been a little difficult to determine the relationship between the settlement and the size of crack that will open. Clogged places extend almost entirely around all the beds, and this affects the size and shape of cracks that will be formed. Fig. 4 shows an average of many measurements made at places where the sand had not clogged. Rough side walls where the sand comes in contact with them offer aid in starting these cracks. A smooth wall is preferable but no vertical surface will prevent the pulling away if there is sufficient settlement. The main cause of the starting of these cracks is that the greatest voids are against the side walls. Any vessel filled with spheres somewhat near the same size will have the greatest voids next to the surface. Consequently the greatest flow of water through a filter bed is along the side walls. In the main part of the bed the water is deflected at practically every sand grain, whereas along the side walls the flow is nearer a straight line. Having larger openings and a straighter line of flow greatly aids in carrying suspended matter below the surface at a more rapid rate than it is being carried at other parts of the bed. The concrete side walls of the filters were roughened where the sand comes in contact with them. These walls, after a slight sedimentation of the sand bed, may have fully 75 per cent of their surface below the sand line with a clear space between them and the sand. This greatly aids the formation of freer passages for the water and starts side filtration. When side filtration starts there is nearly as much tendency to pull the beds horizontally away from the walls as there is downward.

Just after the sand has been run through the washing machine, which removes some of the gelatinous

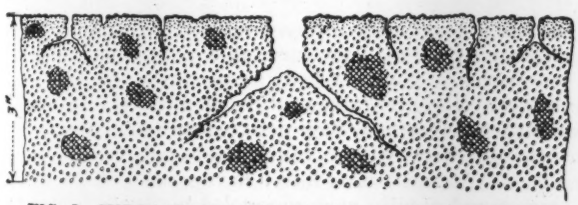


FIG. 7—SURFACE CRACKS IN TOP 3 IN. OF FILTERS OCCURRING IN SPRING AND FALL

Surface area of cracks is twice the original surface area. An area equal to the surface is found ½ in. below the top where the sand is considerably coarser than that on top, consequently practically all filtration is at bottom of cracks.

coating, the beds may not pull away from the side walls more than ⅛ to ¾ in. at the surface, and this pulling away may not extend more than 3 or 4 in. below the surface. At such times the total settlement of the bed is about 0.6 in. As the gelatinous coating becomes thicker on the sand grains, due to a biological action taking place, the beds settle looser after washing. This increases the amount of settlement, and the cracks open deeper and wider, somewhat as shown in Fig. 4.

The large amount of suspended matter thrown into the beds along the side vertical surfaces may be sufficient at times to form clogged masses which adhere sufficiently to prevent being broken up in washing. In some filter plants, where only a thin coating forms on the grains, the settlement is little, and side cracks do not open to a point where they are readily noticeable; consequently the amount of suspended matter carried into the beds at this point is not great, and the force of the wash-water may always be sufficient to prevent clogging. At others thick coatings form, and clogged places will soon form around the side walls. Fig. 5 is an average of what occurs around the side walls of all the Montebello filters in the warmer months.

The first appearance of the formation of these clogged places is that the surface of the sand against

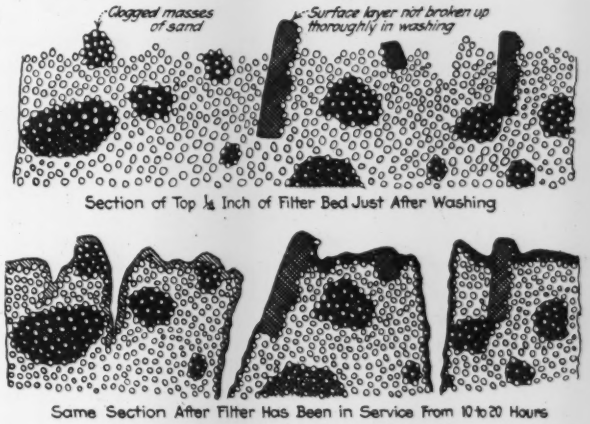

Clogged masses of sand
Surface layer not broken up thoroughly in washing
Section of Top ¼ Inch of Filter Bed Just After Washing
Same Section After Filter Has Been in Service From 10 to 20 Hours

FIG. 8—INSUFFICIENTLY WASHED SAND WITH HEAVY COATING TENDS TO FORM CRACKS QUICKLY

Upper drawing shows action of ¼ in. of filter bed not thoroughly broken up by the wash resulting after 10 to 20 hours in cracks shown in drawing below.

the wall is somewhat higher than the rest of the bed. Clogged places are always found, and are usually near the surface of the gravel. These places, which are of variable size and shape, deflect the wash-water so that there is little tendency to break up additional clogged masses that will form and settle on top of the existing ones. The force of the wash-water does gradually break loose some of the clogged area from the under side, and from its sides, but the masses are usually forming at a more rapid rate than they are being washed away. When the clogged area reaches a point near the surface of the bed its formation slows up, and the rate of washing away equals the rate at which it is being formed. The reason for the horizontal surface sloping towards the side wall, as shown in Fig. 5, is that the wash-water is deflected away from the wall around the clogged area. When the water passes, it has a tendency to draw the water immediately over it into the current, as shown by the arrows. This prevents sand being deposited to a great extent over the clogged area. When the effluent valve is closed, a triangular or wedged-shaped part of the bed next to the walls, from 1 to 5 or 6 in. wide at the surface and coming to a point a few inches below the surface, breaks loose and slides down against the wall. This throws sand containing much suspended matter down in the open space below the break. When the filter is washed the clogged places are forced against the wall, compacting the sand and mud just settled. In this way the clogged places gradually widen themselves, being built up from the side next to the wall until a point is reached where they are being washed away as fast as they are formed.

Settlement Cracks—Clogged places are not confined entirely to that part of the bed around the side walls, for, frequently in the warmer months, places will occur

in various parts of the beds. The gelatinous coating on the sand grains, due to the biological action taking place, becomes so thick and adhesive that the grains readily adhere into masses from a few grains to a mud ball several inches in diameter. These masses are not easily broken up by the wash-water. The smaller the sand grains the greater will be this tendency to adhere, due to the coating usually being thicker on the smaller grains. The fine sand does not have sufficient abrasion in washing to prevent the formation of a thick coating. The formation of clogged places increases the rate of wash through the part not clogged until a point is reached where the flow is sufficient to prevent additional clogging. Under unusual conditions one-half of the bed may become clogged, as is shown in Fig. 6. These clogged masses have their beginning in the fine sand near the surface. When not thoroughly broken loose by the force of the wash-water, they settle to a level near the gravel layer where the bed is not being disturbed by the wash. The abrasion is much greater in this part of the bed, and most of the masses are readily broken up, except in times when there is great adhesion. The adhesion may be so great at times that when the water is drained below the surface, and a wooden board laid flat on the surface and pressed down with a force of about 50 lb. per square foot, the entire surface of the bed under the board will adhere to it and be raised when the board is lifted. Sometimes the thickness of sand adhering is over 3 in. Sand of this nature when compact cannot be broken apart entirely in one washing. As these masses adhere and grow larger the wash-water is deflected in such a manner as to aid

TABLE III—REDUCTION IN VOLUME OF SAND BY REMOVAL OF COATING AND BY COMPACTING

Number of Samples	Location of Samples in Filter Beds	Per Cent Reduction in Volume by Removal of Coating	Per Cent Reduction in Volume by Compacting With Organic Coating	Per Cent Reduction in Volume by Compacting After Removal of Coating	CC. of N/10 Permanganate Necessary to Reduce Organic Matter in One Gram of Wet Sand
8	¼-½ in. below surface	31.4	17.9	11.0	5.0
2	Average of bed.....	16.2	14.1	9.8	2.7
2	18 in. below surface	12.7	12.1	7.2	1.3
5	Clogged near gravel	25.2	18.1	12.5	5.2

Nessler tubes ¾ in. in inside diameter and 14 in. long were used in measuring shrinkage. The wet sand was gradually added to the tubes filled with water, replacing the water as they filled. In this manner it is believed the compactness will about equal that in a filter bed after washing. To obtain the maximum shrinkage possible by compacting, the tubes were rolled between the hands in a vertical position then bumped by dropping from a height of one inch on a wooden board. To remove incrustation sample was treated with sulphuric acid, washed and rubbed with the hand.

in the addition of more of the clogged masses on top of the existing ones. Then there is a race between the abrasion tending to reduce the clogged places from the under side and more deposited on the upper side. If they reach a certain size, settlement cracks begin to form in the surface, which aids in the formation of clogged masses at a much more rapid rate. Almost invariably when cracks occur the clogged places will build themselves up to the surface, and sometimes several inches above, as is shown in Fig. 6. We may readily see why cracks will be formed when there is sand that shrinks about 5 per cent of its depth adjoining clogged sand that shrinks very little.

These cracks sometimes extend nearly to the gravel, and occasionally open so wide that there is a breaking-off of a wedged-shaped mass of the sand when the filter is cut off to be washed, the same as occurs around the side walls. The clogged places then progress in the same manner as the side clogged places.

Surface Cracks—Small surface cracks occur in the filters in the spring and fall every year. They extend from about ½ to 4 or 5 in. below the surface, as shown in Fig. 7. When conditions are favorable for their formation they occur to such an extent in some of the beds that there is scarcely a square inch of the surface that is not cracked. Their cause has been the most difficult

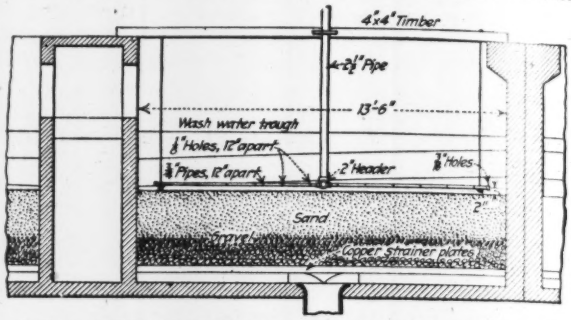


FIG. 9—INSTALLATION OF JETS IN 10 FT. SECTION OF ONE SIDE ONLY OF FILTER 2

Pipes originally, March 8, placed 2 in. above the sand when filtering, were lowered to 3 in. below the surface Aug. 14. It was the intention to raise them to original position when summer conditions were over.

to determine. Why do they occur at certain times only to disappear in a short while, with no great change in the character of water? After the appearance of the article by Wolman and Powell[1] on the shrinkage of filter sand, it was thought their theory of a highly absorptive sand offered a possible explanation, but the authors have not been able to prove the correctness of this theory. The appearance of these cracks to such a marked extent as is shown in Fig. 1 and their complete disappearance in a short while, indicate that if there is absorption it is in the gelatinous coating, and not in the grains themselves. The quickness with which this coating may form on new sand grains under favorable conditions may have misled these authors. No sand has been found that will not form this gelatinous coating when placed in the filter beds at the Montebello filters. In winter, when the temperature of the water is low, the suspended matter does not form a tough layer on the surface, and there is considerable penetration into the beds. At such times filters having sand of 0.4 mm. diameter will readily pass suspended matter before the loss of head reaches 3 or 4 ft. The suspended matter either does not have the toughness necessary to prevent its being forced through the voids in the sand, or there is less adsorptive power in the gelatinous coating. As to whether the voids are larger in winter than in summer, it is impossible to determine. The thickness of the gelatinous coating on the grains is less in winter, indicating that the voids might be smaller, but it is possible the thick summer coating is more plastic and comes nearer filling the voids than do the smaller grains with a harder coating. This, however, is not the entire cause, for new sand without any coating and the first time used builds up a loss of head very rapidly at times in the warmer months.

The rate of increase in the loss of head depends on the area of the voids, the toughness of the matter in suspension and the biological action taking place. The layer formed by the matter in suspension being filtered is weak in the colder months, and a small head readily

breaks. As the temperature increases and there is more organic amorphous matter in the water, the layer increases in toughness and elasticity, and it may require several feet of head to break it. When broken the elasticity tends to open the breaks wider as the loss of head increases. It seems that there is fairly conclusive evidence that the surface layer is slightly elastic. If, when the loss of head has reached several feet, the surface membrane is carefully cut so as to disturb only the few surface grains, a crack will soon form. A thin sheet of paper, a leaf, or any substance having a smooth surface left in the sand so that it will project through the surface, will cause cracks to form.

Ordinarily when sand having a thick gelatinous coating settles after washing, the surface does not settle smooth, but is somewhat as is shown in Fig. 8. This rough surface, changing slightly as the bed settles while filtering, helps produce greater tension at places than there otherwise would be. In winter, when there is not much organic amorphous matter present and no biological action taking place in the beds, the rate of increase is slow, requiring at times about two weeks to reach 8 ft. loss of head, the maximum. In the summer it is very rapid, and at times will go to its maximum in 10 or 12 hours. At such times the membrane is very tough and it does not break over any of the surface except at places where there are settlement cracks. Between these extremes there are times in the fall and spring in which the rate of increase would be fairly rapid, going to its maximum in 16 or 20 hours, if it were not for the cracks formed. Fig. 7 shows how the filtering surface may be greatly increased by cracks. Under such conditions filters will run 30 or 40 hours instead of about twenty.

Is the Coating of Any Benefit?—The trouble produced by an excessively thick gelatinous coating will likely overbalance any benefits derived, but it does not fully justify the assumption that no coating is desirable. Are filters mere strainers, or is the removal of suspended matter dependent on the cohesion or adhesion of substances constituting the filter beds? It is true that most of the suspended matter is strained out in the warmer months, but it is doubtful if all is removed in this manner. Recent experiments indicate that there is no decided advantage in the coating for clarification in the warmer months. A substance of some nature has to adhere to the sand grains to form the coating, yet sterile sand mixed with sterile aluminum hydroxide does not adhere to any appreciable extent. It seems most probable that organic matter produced by the biological action taking place is responsible for the coating. Under no condition has a coating been found that did not have a large percentage of organic matter. The aluminum hydroxide is certainly not an essential. Clean sand placed in the beds in winter, when the temperature is below that necessary for rapid growth of bacteria or micro-organisms, does not form the coating until the temperature rises in the spring, but when placed in the beds in the warmer months one rapidly forms. In the building up of this organic colloidal film, much aluminum hydroxide and other substances in suspension are entrapped. This gelatinous colloid may have the same adherence to these substances as it does to the sand grains. It is believed that this is the substance forming the binding or adhering powers, and if such is the case a thin coating may be desirable.

Preventing of a Thick Gelatinous Coating—Practically all troubles from cracks and clogged places in filter beds, where the proper size sand has been used and there is an even distribtuion of wash-water, may be attributed to the gelatinous coating around the sand grains. It, therefore, seems desirable to prevent the formation of an excessively thick coating, and to remove most of the one already formed. Several methods have suggested themselves. Running the sand through an ejector removes a slight amount, but to rely on such a procedure seems practically impossible, for it would have to be run through every few days at certain times in the warmer months. The sand might be treated with acid, but this is too expensive to be practical. Chlorine helps, and is a partial remedy, but the cost and troubles from taste in the water caused it to be abandoned after two weeks' trial.

Water forced into the beds through jets under pressure while the sand is suspended in washing, seems to offer the most practical solution. Sand that settled 6 per cent of its depth, settled only 1.5 per cent after removing most of the coating with a jet of water in a small experimental filter. Microscopical examinations before using the jet showed all grains coated with the gelatinous film, whereas after washing 20 min. with a ¼-in. jet under 30-lb. pressure, 40 per cent of the grains had all the coating removed, 40 per cent more had it removed over part of the surface and only 10 per cent had the surface entirely covered. If one ¼-in. jet will remove nearly all the coating from 0.1 cu.ft. of badly coated sand in less than 30 min., it seems that there should be no difficulty in obtaining satisfactory results on a large scale with a much lower pressure. A vertical rise of 27 in. per minute is being used in washing filters, but 16 to 18 in. will be sufficient to raise the coarse sand in most any bed. If the additional amount of wash-water necessary to make a total vertical rise of 24 in. per minute is thrown into the sand through jets with the head of the wash-water tanks, much better results will be obtained than with the present method.

To see if such a wash is practical and efficient, a system of ¾-in. lateral pipes was installed in one of the filters, having holes spaced 12 in. apart on each side of the pipe so as to throw the jets horizontally. The holes nearest the side walls are $\frac{7}{16}$ in. in diameter and the others ⅜ in. This gives two holes for each square foot of filter surface. The pipes were first placed 2 in. above the sand while filtering, and later lowered to about 3 in. below the surface. The arrangement of the piping is shown in Fig. 9. The jets were found to be more effective in removing the incrustation from the sand grains when below the surface, if the jets project horizontally. A pressure of 5 lb. is maintained on a gage located 8 ft. above the sand surface and attached to one of the ¾-in. lateral pipes. Filter 2, in which the jets are located, was reconstructed in January, 1923; that is, all the sand and gravel was removed, the gravel thoroughly washed and screened and the sand run through an ejector and Nichols' sand separator. The jets were installed March 8, lowered Aug. 14, and have been used each time the filter was washed. A careful examination of the bed Aug. 18 showed in the part without jets badly clogged places around the side walls, a few clogged places near the center, cracks from ½ to 1 in. wide around the side walls, and a settlement of 1 in. for an 8-ft. loss of head. The part with the jets had no clogged places; the cracks around the

side walls were open from ½ to ⅝ in. and the settlement was 0.3 in. It is planned to raise the pipes to their original position after summer clogging is over.

Care is necessary in washing the filters to prevent the pipes clogging with sand when below the sand surface, and to leave the surface of the sand bed perfectly level after washing. The present method is to open the pressure on the jets in advance of the main wash-water valve, and to close both at the same time, being sure that the valve on the jets is closed all the way by the time the main wash-water valve has closed to 4 in. open. This method of operation has given excellent results, leaving the sand surface level, and there has been practically no trouble from clogged pipes. The water used in the surface wash is equivalent to 4 in. vertical rise per minute when the gage pressure is 5 lb.

A modification of the piping shown in Fig. 9 has been constructed in Filter 11. In the grid the ¾-in. pipes are spaced 2.2 ft. apart, with ⅝-in. holes spaced 12 in. apart on both sides of the pipe. The pipes are 1 in. above the sand surface, and the jets project downward at an angle of 30 deg. to the horizontal. The piping in Filter 2 with ½-in. holes gives an area of 0.025 sq.in. per square foot of surface, and that in Filter 11 has the same area per square foot. Taking into consideration the ⅝-in. holes around the side walls in Filter 2, the amount of wash-water is almost exactly the same. The pipes in Filter 11 have been in service only a short time, but they seem to be just as effective as the ones in Filter 2. They will have the advantage of being above the sand when filtering, and will have less tendency to clog if improperly operated.

The advantages of such arrangement in a filter are:

(1) All underdrains and strainers may be omitted, and only a false bottom for holding the gravel need be constructed. J. W. Armstrong, filtration engineer, is using such a bottom for the new filter units at Baltimore, thus saving considerable in construction cost. The only real argument for underdrains and strainers has been to insure an even distribution of the wash-water with the hope of preventing clogged places. The cost of a system of pipes as used, is only a small per cent of the cost of underdrains.

(2) Such an arrangement insures a clean filter bed, whereas the wash-water when applied from below does not do so in many cases.

(3) Filter runs will be lengthened to from 25 to 50 per cent in the warmer months, resulting in a saving of wash-water, as the usual amount of water is sufficient for the under-wash and the jets.

(4) Filter beds kept in good shape will be more efficient in the removal of suspended matter.

(5) A smaller size sand may be used, insuring more efficient results in the winter months.

(6) Filter beds will be maintained in good shape at a reasonable cost.

Such an arrangement of piping may be supplied with water under sufficient force to prevent excessive lime coatings on the sand grains when the water is softened, or where iron and lime are used as a coagulant. It may be much cheaper than an occasional renewal of the sand, and will likely keep the sand grains to a size where more efficient filtering results will be obtained. If the ordinary wash is sufficient for some waters, it is not believed a great force is necessary for any ordinary condition, and the present arrangement may be in excess of actual needs for most plants. It is surprising, however, that some accelerated force is not more generally used. Only two references to such an installation have been found, one of which possibly never passed beyond the experimental stage. Had DeBerard and Pearse's[3] arrangement of jets suggested fifteen years ago been tried where there was excessive clogging many plants would now have such an installation.

Conclusions as to Sand Size Most Suitable—It is evident that the size of sand most suitable for summer conditions is not that which is most suitable for winter. The depth to which cracks open into the beds justifies the conclusion that 15 to 18 in. of sand, 1.0 mm. in diameter as determined by sieves, will filter all coagulated suspended matter in the warmer months. The ease with which suspended matter passes in winter leads to the belief that a much finer sand is desirable. The presence of highly adhesive organic colloids in the gelatinous coating in summer makes filtration largely a problem of getting the water through the filters, without any great attention being paid to the size of sand used insofar as it pertains to the removal of suspended matter. When the temperature of the water is too low for biological action, this adhesive matter is gradually worn off in washing to a point where it is so filled with silt and other hard substances that it will lose much of its adhesive powers. The adhesion between the sand and suspended matter then approaches that of clean sand, which is very little. Consequently, for efficient results in winter, we should not ignore entirely the conditions best suited for straining out the suspended matter. A hydraulicly graded bed turned bottom side up would be more ideal for straining; however, this condition cannot be obtained in sand filters. The only approach to such a condition is to have sand of uniform size for that part of the bed relied on for filtration. Fine sand overlying very coarse sand is certainly not ideal for straining. Suspended particles broken fine enough to pass small voids will more readily pass the larger ones. Whatever be the size of sand in the surface layer, it should be of uniform size and deep enough to remove practically all suspended matter in the colder months.

These conditions should be borne in mind:

Cracks should not be allowed to form.

To avoid cracks the beds should not settle more than ½ in.

Clean sand of 0.30 mm. diameter, with no gelatinous film, will settle approximately 1.5 per cent of its depth, and 1.0-mm. sand will settle about 1.2 per cent.

A very thin film will add greatly to the settlement.

Sand coarse enough to prevent cracks and clogged places in the warmer months will be entirely too coarse for winter.

Fairly fine sand that is reasonably efficient in winter may, with some additional force applied to the wash, be made suitable for summer use.

The gelatinous film should not be entirely removed.

The coarser the sand the deeper it will be necessary for the filtering layer to be.

Taking into consideration all these factors, it seems that a very uniform and round sand of about 0.60 mm. diameter for the top 16 to 18 in. will be the size most suitable for water like that handled at the Montebello plant.

[*Discussion of the above article will be published in an early issue.*—EDITOR.]

[1]Wolman, Abel, and Powell, S. T.: "The Surface Shrinkage of Rapid Filter Sand Beds." *Eng. News-Record*, Vol. 85, No. 5, July 29, 1920, p. 210. Discussion Sept. 2, 1920, p. 438.

[2]"Filter Underdrain, Sand Bed and Wash-Water Experience." *Eng. News-Record*, Vol. 85, No. 21, Nov. 11 and 18, 1920, pp. 934 and 984.

[3]DeBerard, W. W., and Pearse, Langdon: "The Testing Station and Filter Plant Improvements of the Peoples Water Co., Oakland, Calif." *Eng. Record*, Vol. 58, No. 4, July 25, 1908, p. 97.

[4]Amsbary, F. C.: "Further Development of Iron Removal Plant of the Champaign and Urbana (Ill.) Water Co." Proc. A. W. W. A. 1916, p. 400.

[5]Babbitt, Harold E.: "Wash Water Salvage at Champaign and Urbana." Proc. A. W. W. A., 1915, p. 393.

Engineering Impressions of Bermuda

Where Every House Is Its Own Water-Works and Building Stone Is Cut With Hand-Saws

By E. J. Mehren
Vice-president, McGraw-Hill Company

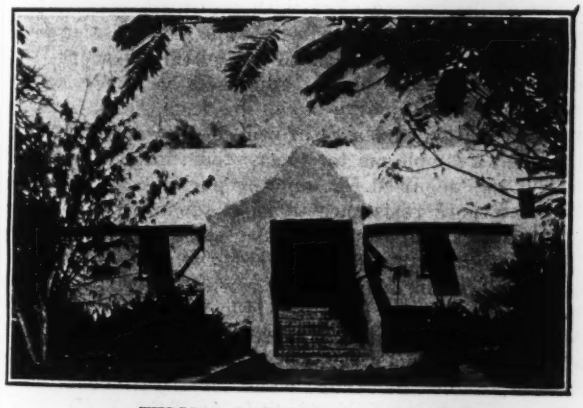
TO THE average tourist, Bermuda is a land of intriguing leisure, of agreeable climate, of attractive scenery, of limpid, turquoise-green water, and of wonderful marine vistas.

The engineer visitor to the island is no less sensible to these charms than is the lay tourist, but he has, in addition, the interest that comes from being in a land where every house is its own water-works, where homes are built of stone so soft that it is cut with ease by hand-saws, where means of transport, save for the motor boat and the bicycle, are limited to horses and horse-drawn vehicles. From the engineering point of view, then, Bermuda furnishes quite as much contrast to the United States and Canada, from which most of the tourists come, as it does scenically and in its mode of life.

It is proposed to set down here some impressions of two of the engineering features of the island—its water supply and its building practice—and to give bare mention to a transportation discussion now under way there.

First, though, it will help the understanding of these engineering features if the geography and the elements of the geology of the island are understood.

Geography and Geology—Some 700 miles southeast of New York, out in the Atlantic, on the southeastern



TYPICAL BERMUDIAN HOME
Built of soft native stone and stuccoed.

flank of the Gulf Stream, due east from Cape Hatteras, there rises from the ocean floor, at that point 15,000 ft. beneath the water's surface, a volcanic pinnacle whose igneous-rock top is some 1,100 ft. below water level. (The term "pinnacle" is used advisedly, for the oceanographers tell us that no mountain on the earth's surface presents, for equal height, slopes as steep as the rock that is, or that supports, Bermuda.) On this volcanic pinnacle, corals and other forms of marine life have built up through the ages an area of reefs, roughly 30 miles long and 15 miles wide. The accumulated debris of these reefs, piled up by the waves, and subsequently by winds, forms the land mass of Bermuda, a serrated group of islands, 26 miles in length, and but a little more than a mile in width across the broadest part of the land mass.

The rock above the igneous mass is pure limestone or what is commonly known as Aeolian limestone. The lower stratum, coming up to water level, and in some places outcropping above it, is quite hard, furnishing for the horse-drawn traffic of the islands an acceptable road stone. Above water level the limestone consists of "hardened sand dunes," soft, porous, weighing approximately 75 lb. to the cubic foot.

This fragmentary statement of the island's geography and geology, however inadequate, gives a clue to

BERMUDIAN HIGHWAY
Waterbound macadam is used exclusively, and stands up well in the absence of auto traffic and heavy loads.

the water supply and the building practice of Bermuda. Let there be added that the land area, divided among numerous small islands, measures 19.3 sq.mi. and that the population is 21,000 to 22,000, which gives the high density figure of over 1,000 inhabitants per square mile.

Water Supply—At bottom, it is the porosity of the rock that accounts for Bermuda's water-supply problem. The rock soaks up water like a sponge. The water runs through the rock, one might say, rather than over it. Consequently, there are no fresh-water accumulations, in streams or lakes. At the same time, the detachment of the Bermuda pinnacle from large land masses and the geologic formation remove the possibility of artesian supplies.

Nature failing, therefore, to furnish accumulating and storage facilities, man must do it for himself. So, every roof is carefully guttered and the cistern is the householder's storage reservoir. Fortunately for the Bermudian, nature is kind to him in both volume and distribution of rainfall. For thirty-three years the average precipitation has been 58 in. For the last five years, the average has been only 50 in., while the low record in thirty-three years has been 39 in. More important, though, is the distribution of the precipitation. It is remarkably uniform, as the average monthly precipitation varies from 3¾ to 6½ in.

It is of interest to state here that the laws of the islands, colonial possessions of the British Empire, require each householder to provide his own individual water supply in the manner outlined in the preceding paragraph.

The colored population, about 75 per cent of the total, consumes from 7 to 10 gal. per person per day, and finds its needs amply provided for, except in the driest years, by a home storage tank varying from 5,000 to 8,000 imp. gal. capacity. The white population, with larger roof areas to serve as catchment, provides larger tanks, and as a rule secures a large enough supply not merely for drinking, but for bathing and

washing. One householder, a leading citizen of the island, stores 45,000 imp. gal.

The hotels, catering principally to American and Canadian visitors, accustomed to very liberal use of water, have, naturally, a more difficult problem than have the individual householders. Even so, by carefully guttering all of their buildings, some, even of the large hotels, with a limited tourist season, are able to supply their own needs. Others have to buy water from the few commercial watersheds on the islands and from steamers which bring water in ballast from New York.

Where supplies larger than can be obtained from roof areas are needed, the practice is to construct a watershed on a hillside, with a storage reservoir at the bottom. These watersheds are built by clearing off the soil—averaging 1 to 2 ft. in depth—evening up the rock somewhat, and giving the whole cleared area a coat of cement mortar. The surface is whitewashed, not merely for the sake of appearance, but also to close up the shrinkage cracks in the mortar facing, prevent plant growths and maintain a clean surface.

The largest of these artificial water catches is that constructed by the Bermuda Development Co., Ltd., at the Mid-Ocean Club, where a 3½-acre hillside has been developed. At the present time, under the direction of Paul H. Norcross, consulting engineer of Atlanta,

SAWING BUILDING STONE

Ordinary crosscut saws and broad hand chisels are the only tools used.

Georgia, a reinforced-concrete reservoir is being built at the foot of this watershed, providing a storage of 1,500,000 imp. gal. and furnishing water not merely for the club building, but a reserve supply for cottages that will be built on the club property and also for the watering of the golf-course greens. (For much of the information in this article the writer is indebted to M. S. Singleton, Mr. Norcross' representative in Bermuda.)

Bermuda serves as a port of call for vessels in the transatlantic trade, particularly those headed for or coming from Canadian, West Indian and Central American ports. There are several direct lines to Europe.

Vessels calling frequently desire fresh water supplies as well as fuel and for that reason several hillside watersheds have been built by shipping agents for this trade.

To some extent, the fresh water supplies are supplemented, by the large hotels and other large users, by a brackish water for washing purposes. These supplies, which in most cases are more or less subject to local pollution, are secured from shallow wells [illegible]rried only a few inches below standing water level, [illegible] taking off the fresh water, partially mixed with [illegible] that floats on the sea water.

Building Construction—Even as the individual householder must supply his own water-works, so he could, if he desired, get his major building material, stone for the walls, from his own domain. In other words, the soft coral and shell limestone is everywhere present, covered only with a thin layer of soil. In fact, as one rides about the islands, he gains the impression that in earlier days each householder did open his own quarry. Abandoned workings are found everywhere. The later tendency has been to secure stone from certain quarries where fairly high faces can be worked. In many instances building stone is obtained from the excavation necessary for the householder's water catch reservoir.

SAWING DOWN A LARGE BLOCK OF STONE

As the accompanying photographs plainly show, the material is worked with the greatest ease. Crosscut saws such as are used on lumber, and a chisel 2 in. wide fitted with varying lengths of handles up to 23 or 24 ft., are the only tools required. A kerf parallel to the face of the quarry is cut down for the full height of the desired block with the chisel, the quarryman standing on top of the block. The long crosscut saw, 7½ ft. in length, is then used for cutting down on the fourth side of the block (two faces naturally being exposed). These quarry blocks are usually 6 ft. square and 20 ft. high, and are thrown over by undercutting. It is then a simple matter to saw them into the various sized blocks required for building purposes. The stone offers no more resistance to hand sawing than does a gypsum block, but has a granular and gritty texture.

For building purposes the stone is cut into blocks 6 in. thick, 24 in. long, and of a width depending upon the position in the building. Blocks 10 in. wide (in other words, a 10-in. wall, disregarding the stucco coat on the outside and the inside plastering) are used for one-story buildings, 12-in. walls for the first story of a two-story building, and 14-in. walls for the first story of a three-story building. The roof "slates," as they are called, are of the same soft stone, 12 in. wide, 18 in. long, and 1 in. thick. They are laid in mortar, using a 9-in. lap, and rest upon heavy lath 9 in. on centers. Gutters are made of triangular lengths of stone and are laid at convenient slopes right on the roof. The hung type of metal gutter, customary with us, is not in use. The roof and the walls are stuccoed with a smooth plaster applied by hand and then whitewashed. The stucco is a portland cement and sand mixture, in proportions of 1:4, with a small amount of lime to make it work easily. The typical Bermudian home is shown in the accompanying photographs.

Water storage reservoirs are cut in the ground, that is, in the soft stone, and plastered inside with cement mortar. The sewage is disposed of in deep pits generally 4 x 6 ft. in plan and 10 ft. deep, which require cleaning only at long intervals.

Dry rot is an enemy that must be carefully combatted. The climate is quite damp and all spaces normally closed in our practice are carefully ventilated. This includes spaces between floors and under the roof.

A NOVEL "MOVABLE" BRIDGE

The middle portion is removable, allowing an 18-in. space for passing the masts of small fishing vessels.

Moreover, heartwood pitch pine and cedar will alone resist the inroads of dry rot, even where the ventilation is good. The native cedar cannot be secured in large quantities, and consequently the main dependence is on Georgia pine.

Transportation—Bermuda probably has the unique distinction of being the only place in the world that has successfully resisted the advent of the motor car and the motor truck. Within the confines of private property the use of motor vehicles is, of course, permitted, but they are not allowed on the public highways. In consequence, the number of motor vehicles on the island is practically nil, a few trucks being in use at the Admiralty Dockyard and on private estates. The obvious reason for the restriction of the motor car is that they are quite incompatible with the leisure and quiet of the island; in this restriction most of the tourists seem heartily to agree.

However, there has been agitation for years for some better mode of transportation. There are advocates of the general use of automobiles. Some want a motor-bus service on the public highways, while others prefer the construction of a light railway, using gasoline-propelled vehicles. A light-railway scheme has been developed and proposed by Robert A. Cummings, consulting engineer, Pittsburgh, Pa., and is now before the Colonial Parliament. Opponents of motor buses cite as objections to the bus the narrowness and winding character of the Bermudian highways and the inadequacy of macadam roads for carrying fast-moving traffic. Opponents of the light railway stress the fact that it will cut up the island by a disfiguring right-of-way.

As to the choice between these alternatives the tourist has relatively little interest. On the whole, however, some more frequent, convenient and economical mode of transport would be welcomed by him, particularly if he stays any length of time.

As to transportation, however, it might be remarked that most of the tourists are far less concerned with the mode of transport in the islands than they are with the transportation between New York and Bermuda. On two trips to the islands the writer has found that the visitors pray for the day when some genius will invent a mode of sea transport quite as stable as is the railroad on dry land.

Revetment of Stone and Wire Mesh Placed as Continuous Layer

A COMBINATION of wire fencing and stones has been used extensively as bank protection along Los Angeles County water courses. Some four or five miles of bank have been protected in this way with revetments placed during the last few years, in which time improvements in methods have developed. As now laid by county flood-control forces, an entire slope is protected by a facing of wire-bound stone laid as a single sheet or layer. Previous descriptions of earlier forms of this revetment appeared in *Engineering News-Record*, Feb. 6, 1919, p. 301; April 22, 1920, p. 834; and Nov. 9, 1922, p. 801.

Although the cost of this revetment is much less than for any form of concrete wall, its chief advantage is its flexibility; when undermined it will deflect and follow the contour of the new slope, continuing to give protection to the bank. Instances are on record of this type of revetment having turned completely over and still remaining intact and serviceable.

Under the plan at present followed in Los Angeles County, the bank is first graded to a 2½ to 1 slope and a layer of standard wire fencing is spread on the slope

SINGLE-SHEET STONE REVETMENT, SAN ANTONIO WASH

and held down by stakes. The strips of fencing are laid with edges slightly overlapping, and these edges are wired together. Tie wires or "tufting" for later connection with the upper course of wire are fastened to this ground sheet on 12 to 18-in. centers in both directions. Stones, of any size larger than the mesh opening and not exceeding the weight that one man can carry, are then placed, the stone layer being 8 in. to 1 ft. thick. The top wire fencing sheet is laid by unrolling the strips on the stones and wiring together the edges of adjoining strips. Finally the tie wires projecting through the stones are wired to the top sheet of fencing and the work is finished.

San Francisco Ferry Traffic During 1923

A total of 51,592,711 people passed through the San Francisco Ferry Building during 1923, according to report by John K. Bulger, supervising inspector of steam vessels. Totals for the transportation companies are:

Southern Pacific Co.	27,341,294
S. F. and Oakland Terminal Ry.	16,685,643
Northwestern Pacific Co.	6,682,261
Monticello Steamship Co.	607,582
Santa Fe Co.	183,168
Western Pacific Co.	92,364
Petaluma & Santa Rosa Railway Co.	399

Findings and Deductions from Highway Traffic Surv[illegible]s

Practical Uses of Transportation Surveys Enumerated — Connecticut and California Su[illegible] Summarized in Nineteen Original Graphs—Economic Fields of Truck Transportatio[illegible]

By J. Gordon McKay

Chief, Division of Highway Economics and Transport, Bureau of Public Roads, Washington, D. C.

Abstract of a paper read before the American Road Builders Association at Chicago, Jan. 17, 1924.

HIGHWAY transportation deals with the movement of persons and commodities over the highways and concerns the instruments of transportation, the highway and the vehicle, as well as the transportation services rendered by these instruments. The following discussion outlines briefly the value of highway traffic surveys, and some of the results obtained from these surveys in Connecticut and California, in general, may be set forth as follows:

1. The selection of highways to be improved in the order of their importance as traffic routes can be accurately determined from a traffic survey. By measuring the density of passenger and truck movement at selected points on the primary and secondary systems the relative importance of different routes is established.

2. Highway design and construction can be adapted to the traffic load on different highways. The traffic load per

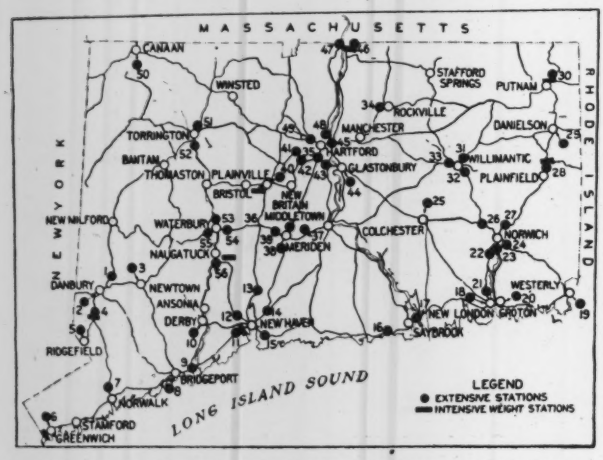


FIG. 1—CONNECTICUT TRAFFIC SURVEY STATIONS

mile of highway varies not only with the volume of traffic but with the type of traffic and the range in weight of traffic units. Variation in the proportion of horse-drawn vehicles, passenger buses, and motor trucks on various routes will greatly modify the traffic load even though the density of vehicles per mile may be uniform. The predominating capacity of trucks used, gross weights, wheel loads, and type of motor truck tires used are also of great importance in the determination of the type of highway construction required to carry the traffic load.

3. The measurement of the traffic load on highways which have been completed for various numbers of years will result in a satisfactory measure of the traffic capacity endurance qualities and life of various types of highway construction. In other words, all highways on which traffic is measured become "test roads."

4. Information concerning the type and volume of traffic on different routes is an excellent guide in proportioning yearly highway construction and maintenance expenditures.

5. Seasonal records of traffic during the winter months are of value in determining routes which require snow removal, and load limitations. The greater the volume of traffic, the greater the need for snow removal, and depending on the type of construction, load restrictions during the spring months.

6. The density of traffic and the type of traffic on different routes are of value in determing not only the type of construction but the minimum width of the highway. Highway congestion near centers of population may require wider roadways near cities and a decrease in width with distance from cities. The width necessary and the point at which normal road width is sufficient to handle the traffic can be very closely determined from traffic records.

7. The problem of whether or not it is economically advisable to reduce grades on a section of highway may well be considered from the point of view of the volume of highway traffic moving over the section under consideration. Expensive grade reductions may be justified in the saving in vehicle operation costs, if the route is a heavy-traffic route. Traffic records of the density of traffic, truck capacities and the total volume of tonnage moving are of value in solving these problems.

8. Traffic records determine to what extent traffic is compelled to use a longer route due to the type, condition, structures, grades, etc., of the shorter route, as well as the saving in passenger and ton mileage resulting from improvement of certain sections of highway. The evaluation of this saving in passenger and ton mileage and the comparison of this sum with the cost of the improvement is economically justifiable.

9. The order of improvement of rail crossings or underpasses, bad turns, traffic bottle-necks and through-traffic detours around small towns can be laid out in proportion to the relative importance of traffic routes as determined from a survey of highway traffic.

10. Sections of the highway system carrying heavy traffic with larger proportions of motor truck movements naturally require more policing and protection of traffic. Adequate guard rail protection, warning signs, and sections requiring strict police control of traffic can be determined with a reasonable degree of accuracy from traffic records.

11. A transport survey produces information of value concerning motor truck overloading—the percentage of motor truck overloads, overloads per capacity, by wheel loads and by body widths. This type of information makes possible the setting up of scientific regulatory legislation which will conserve the highway investment and place the determination of law violation on a basis which can be easily enforced. In addition, for the purpose of checking violations of the law, it indicates the routes on which overloading is most prevalent.

12. Economic highway transportation information concerning the volume of tonnage shipped by motor truck, changes in marketing methods, and the relation of highway transportation to other types of transportation is made available.

13. A very practical use of the information developed from a transportation survey is the measuring of the service value of a state highway system during a given period of time. Having measured the passenger mileage and the ton mileage over the highway system, it is not difficult to compute the total service value produced by the state highway system during a given period of time. It is a less difficult task to obtain funds for highway expenditures, whether from current revenues, bond issues, or both, if you can set on the credit side of the highway ledger the actual value of the highway service. It is no longer necessary to justify expenditures for a highway improvement program by abstract statements of miles completed or the urgent need for new construction. You can make your budget and support the need for funds with the actual dollar value of the highway service produced.

14. Highway traffic is constantly changing in type and volume. The increase in registration is of little value in predicting what traffic a specific route will be required to carry in five or ten years. Your present improvement program, however, is based not only on present but upon future traffic demands. The traffic survey can be used to predict future traffic in two ways: (1) The traffic survey may be continued at periodic intervals over a sufficient

period of time to determine the rate of traffic growth, and this trend applied to future traffic. (2) By correlating the passenger and tonnage movement with population, production, wealth, vehicle registration and other factors influencing the kind and volume of traffic, the quantitative relation of these factors to traffic may be determined, and in this manner a fairly close approximation can be made of the future traffic on the highways in different sections of the state. Additional information of economic value such as the movement of commodities, the zone of motor-truck transportation, the correlation of highway transportation with other types of transporation are more general in nature.

Highway Transport Survey Methods—The Connecticut transport survey which was operated for a year period and closed in October, 1923, and the Pennsylvania transport survey, which began operating in November, 1923, will be used as a basis of explanation of the methods used.

The surveys include two types of research. (1) Intensive data are recorded at key stations where detailed motor truck information is recorded. (2) Extensive data are recorded at a larger number of recording stations divided into districts with one weighing station as the nucleus of the extensive recording stations in each district. This combination of intensive data and recording data insures a reasonably accurate measure of highway transportation. Fig. 1 shows the traffic-survey stations in the Connecticut survey. The weighing stations were operated one week every two months and the recording stations one day each month. By moving the parties from station to station on a regular schedule, with changed hours for day operation and periodic night records, daily, seasonal and total traffic was measured.

Graph Records of Results—The essential results of the transport surveys in Connecticut and California are most clearly visualized by representing them by graphs. These graphs, Figs. 2 to 19, are self-explanatory and require comment only in a few cases.

In the graph of average daily movement of motor trucks and passenger cars on Connecticut Highways, Fig. 2, it requires to be noted that:

1. The primary system in Connecticut carries the bulk of highway traffic.

2. The graph indicates major and minor traffic routes and designates highways which require the largest outlay for construction and maintenance.

3. The graph also clearly indicates the major traffic routes which require constant supervision of construction, maintenance and policing to insure service and safety to traffic.

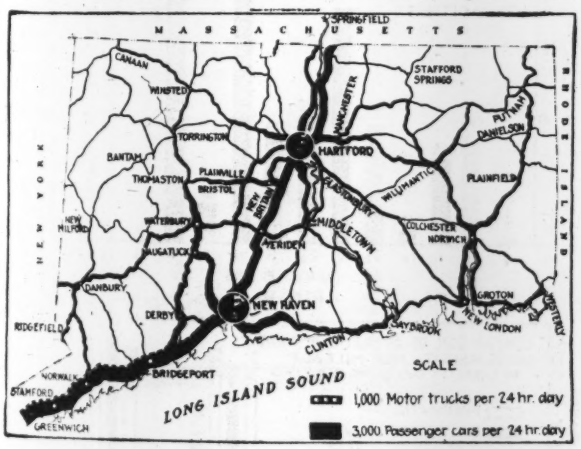


FIG. 2—AVERAGE DAILY TRAFFIC, CONNECTICUT

Representing average daily movement of trucks and passenger vehicles on the Connecticut highway system from Sept. 11 to Dec. 3, 1922.

4. The greatest density of highway traffic in Connecticut is between centers of population, production and distribution.

5. Motor truck traffic is a considerably larger proportion of the total traffic on the Boston Post Road from New York City to New Haven and Hartford.

In the graph of net tonnage transported by motor trucks, Fig. 12, it may be noted that during the three months from Sept. 11 to Dec. 3, 1922, 1,019,000 net tons, and during the year period from September, 1922, to September, 1923, approximately 3,000,000 net tons of commodities were transported by motor truck over the Connecticut highway system.

The total highway net tonnage during the year period was transported 150,000,000 ton-miles. Using 2c. per ton-mile as a conservative charge for the highway service per mile the value of the highway service during the year for

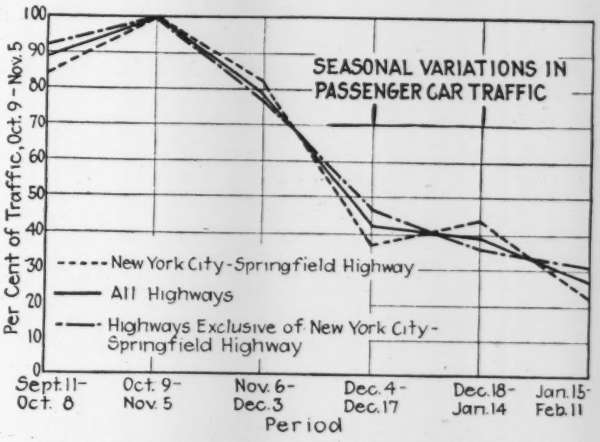


FIG. 3—SEASONAL VARIATIONS IN PASSENGER CAR TRAFFIC IN CONNECTICUT, 1922-1923

motor trucks alone amounted to $3,000,000. This figure does not include the highway service value of passenger car traffic which is from 85 to 90 per cent of the total traffic.

During the period from September to December, 1922, railroad transportation in Connecticut was at low ebb and the decreased efficiency of rail service due to the rail strike of July 1, 1922, naturally resulted in an increase in the volume of freight transported over the highways.

It is illuminating to find that 36.9 per cent of the Connecticut tonnage was hauled 1 to 9 miles, a local transportation of commodities which is non-competitive with rail or water service; 30.5 was transported from 10 to 29 miles, largely a non-competitive movement. Two-thirds of the total net tonnage were moved less than 30 miles. The other third moving 30 miles or more is partially competitive movement.

Motor truck transportation of commodities in New England as shown by Fig. 17 is largely limited to the movement of finished or semi-finished goods. Of the total tonnage 73.6 per cent is manufactured goods, 8.5 products of agriculture, 7.1 products of animals, 6.7 products of mines, and 4.1 products of forests. It is natural in an industrial area that a considerably larger proportion of the goods transported by motor truck will be manufactured goods. There is, however, a more logical explanation of the fact that 73.6 of the commodities is of small bulk, and high value for the margin of profit is considerably larger than in transporting the heavier and more bulky products of forests and mines.

A comparison of Connecticut and California traffic is given by Fig. 19. There will be noted the fairly close agreement of the percentage of tonnage transported in each mileage zone in the two states, indicating that the zone of highway transportation of freight is largely a short-haul movement approximately within 30 miles.

The analysis of motor truck transportation during the spring months of 1923 in Connecticut indicated that with an improvement in rail transportation the percentage of freight transported more than 30 miles by motor truck is decreasing in the New England territory.

An investigation recently completed in New England based on computations of the principal manufacturers in the territory indicates that of their total output 15.9 per cent is shipped in carload shipments by rail; 47.4 in less-than-carload shipments by rail; 29 by motor truck; 7.7 by railway express.

One of the outstanding developments of the present era of motor truck transportation in New England is the sharp

competition existing between interurban motor-truck operators. They do not operate on the basis of published tariffs since rates fluctuate rapidly due to the underbidding of small motor-truck organizations and irregular operators. One-half of the commercial trucking companies operate from 1 to 5 trucks, while only 1.5 per cent of the companies have more than one motor-truck terminal.

There is a lack of uniformity in rate making. Rail rates, mileage, tonnage available, what the traffic will bear, and the probability of return loads are the control factors.

The change in motor truck rates which in... es the stage of competition is shown by the following reduc- tions. The average motor truck rate per 10... from

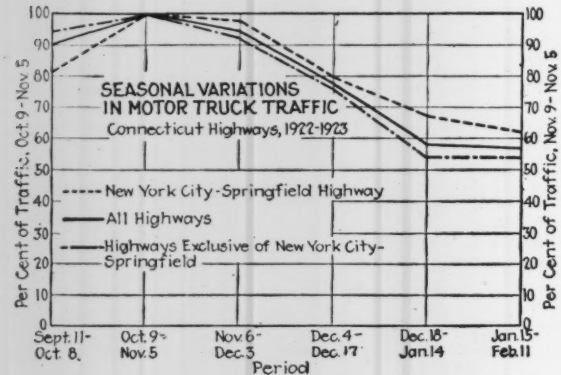


FIG. 4

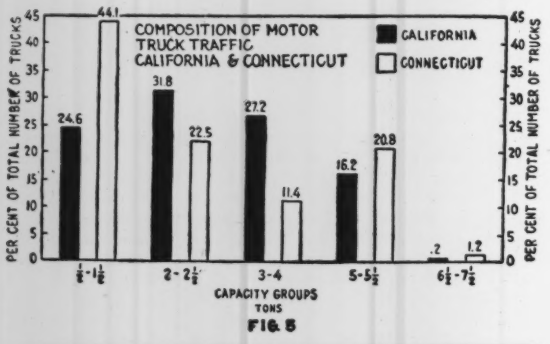


FIG. 5

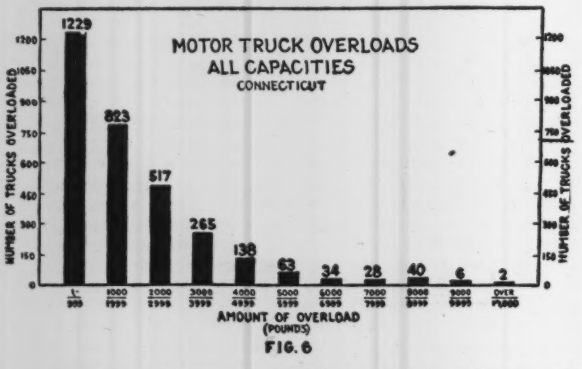


FIG. 6

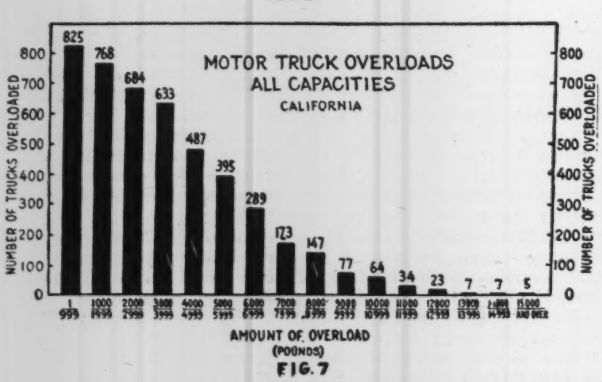


FIG. 7

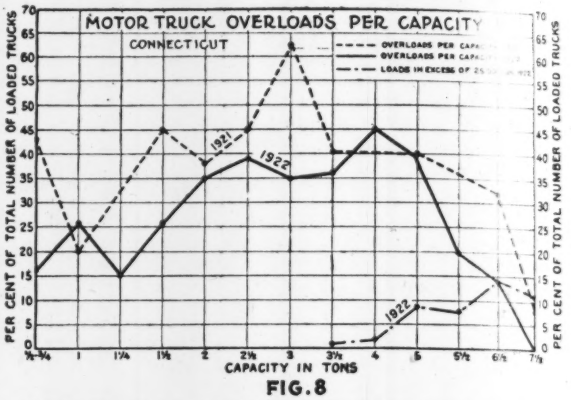


FIG. 8

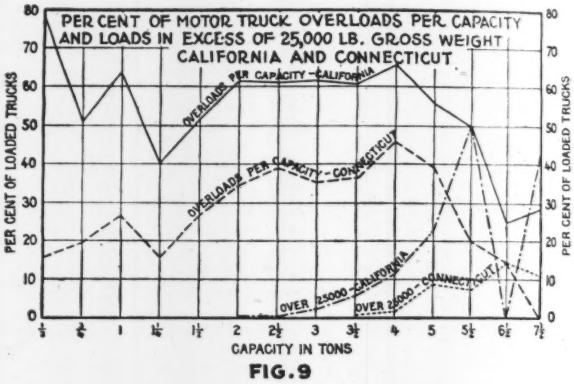

PER CENT OF MOTOR TRUCK OVERLOADS PER CAPACITY AND LOADS IN EXCESS OF 25,000 LB. GROSS WEIGHT
CALIFORNIA AND CONNECTICUT
OVERLOADS PER CAPACITY - CALIFORNIA
OVERLOADS PER CAPACITY - CONNECTICUT
OVER 25000 - CALIFORNIA
OVER 25000 - CONNECTICUT
PER CENT OF LOADED TRUCKS
CAPACITY IN TONS

FIG. 9

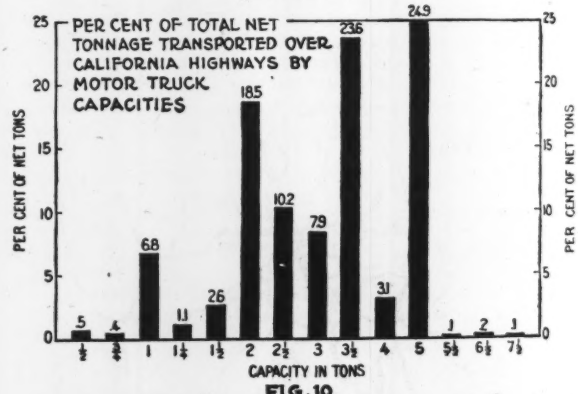


FIG. 10

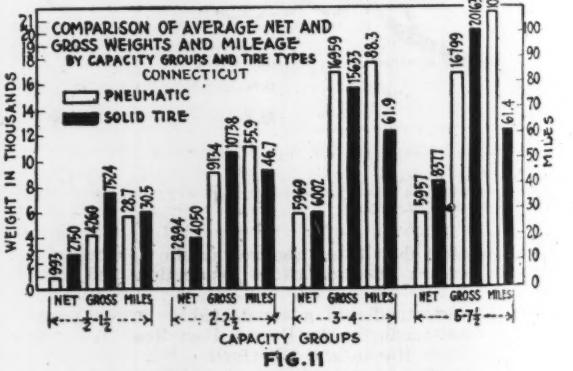


FIG. 11

FIGS. 4-11—MOTOR TRUCK TRAFFIC VARIATIONS AND OVERLOADS IN CONNECTICUT AND CALIFORNIA

New Britain to New York City decreased 52 per cent from 1921 to 1923; from Waterbury, Conn., to New York City, 51; from Hartford, Conn., to New York City, 47; and from New York City to Bridgeport, Conn., 45.

Fields for Motor Trucks—The importance of motor truck transportation as an integral part of our national transportation system is growing in significance and I am venturing to set forth in the order of their importance a brief statement of the four main fields of motor truck transportation.

1. Organized urban motor truck transportation in congested terminal areas consisting of motor truck terminal to terminal freight transfers as well as pick-up to delivery service. This can be illustrated by the operation of the U. S. Trucking Co. in New York City in co-operation with the Erie R.R. in the transfer of freight from the Erie-New Jersey terminal to New York City for delivery. Carefully organized and efficiently operated motor trucking companies, assured of rail and steamship co-operation, will materially speed-up terminal freight movement, decrease the volume of freight warehoused, reduce the cost of moving freight through terminals and expedite the rail delivery time of l. c. l. freight.

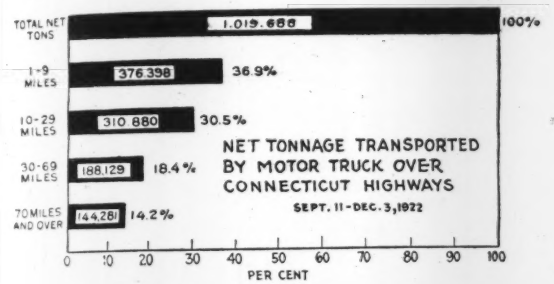


FIG. 12

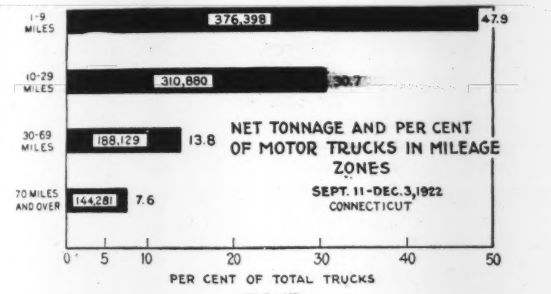


FIG. 13

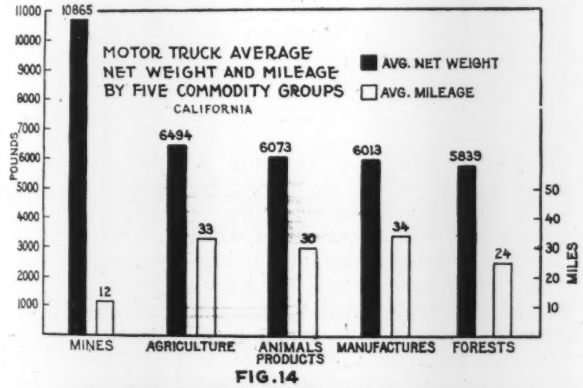


FIG. 14

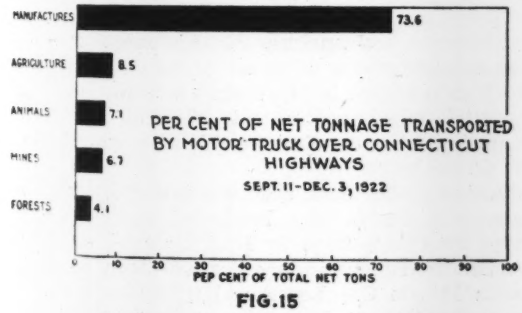


FIG. 15

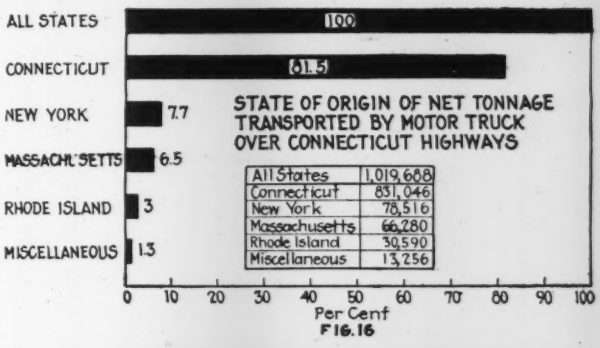


FIG. 16

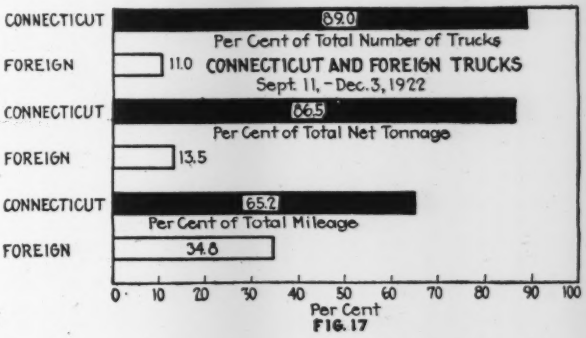


FIG. 17

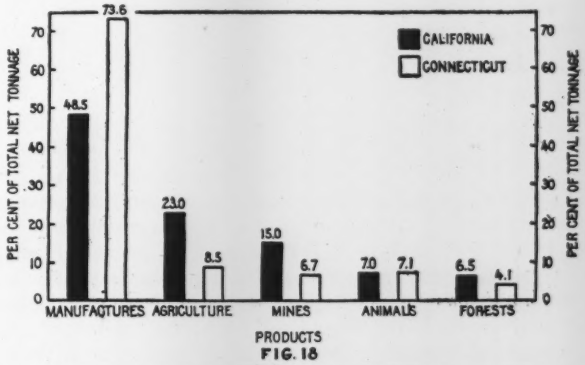


FIG. 18

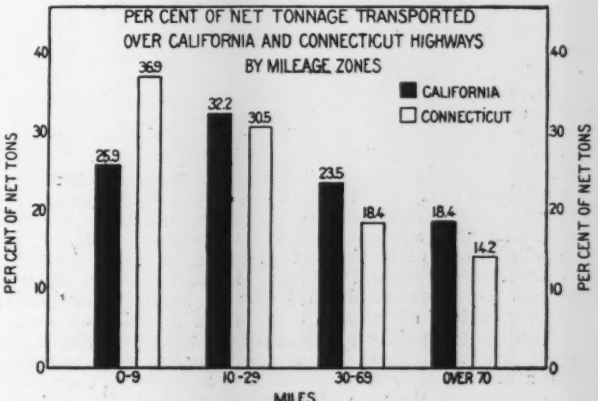


FIG. 19

FIGS. 12-19—MOTOR TRUCK TRAFFIC TONNAGES AND HAULS IN CONNECTICUT AND CALIFORNIA

2. The organization of motor truck freight service to supplement and extend existing rail and water transportation agencies. The development of motor transportation companies in areas inadequately served with rail or water transportation offers an enormous possibility for the economic extension of highway transportation. This type of service is especially desirable in the development of new areas or localities with insufficient transportation facilities and will make available additional tonnage for movement by rail or water. This is a non-competitive service extending and supplementing existing rail and water agencies.

3. The short haul transportation of freight probably not to exceed 30 miles. The freight transported by motor trucks in the short haul zone is largely a non-competitive assembly and distribution of commodities. The difference in the density of population in different areas, the distances between cities and areas of production and distribution, the prevailing type of production and the type of rail or water transportation available may decrease or increase the above zone of the short haul.

4. Motor truck transportation of a limited number of special commodities in the long haul zone in which delivery time, the character of the goods transported or the demands of the industry or trade indicate the desirability of motor truck transportation. This type of freight is but a small percentage of the total net tonnage transported.

Combined motor truck and boat and motor trucks and rail l. c. l. transportation is developing in the New England territory. The Stear Boat Line in New Haven transports freight from Connecticut inland cities to New Haven by motor truck and from New Haven to New York City by boat. Correlated motor truck and rail transportation is developing in New England similar to the joint motor truck and water transportation of freight. The service performed by Stone's Motor Truck Express is typical of this development. Freight is transported by motor truck to selected rail shipping points and the long haul l. c. l freight is handled in carload lots. The same type of truck and rail service is being developed in territory tributary to Philadelphia, Baltimore, Washington, Camden, New Jersey and the correlation of highway transportation with rail and water agencies in the movement of freight is an economic function of motor transportation and offers an extensive field of development supplementing rail and water service. It is not competitive, provides a pick-up and delivery service, allocates the short haul to motor truck transportation and the long haul to rail and water, and provides rapid transportation of freight.

Against Iodinizing Water to Prevent Goitre

The consensus of opinion brought out at the recent Ohio Conference on Water Purification by a discussion on introducing iodine into public water-supplies in parts of the country where goitre is prevalent was against the practice. The following summary of conclusions from the discussion has been made for *Engineering News-Record* by F. H. Waring, principal assistant engineer, Ohio Department of Health, Columbus:

(1) Iodine taken into the human system in any form in small amounts regularly constitutes a preventive of simple goitre. (2) Use of iodine is not injurious if taken in small amounts, for example 10 to 20 mg. per week. (3) Iodine does not aggravate cases of simple goitre already developed but on the contrary is a marked benefit in a large percentage of instances. (4) For goitre prevention iodine is best given individually through specially prepared chocolate-covered tablets known under the trade name of iodostarin, these tablets being of 10 mg. content. (5) Medical authorities who have made a study of goitre prevention are inclined to recommend that manufacturers of common table salt be compelled to leave in the salt prepared for usual domestic consumption a "normal" amount of iodine. This amount has not yet been established but is being investigated. (6) Application of iodine in any form to drinking water constituting the public water supply is not advisable, being rather wasteful; furthermore the practice is undesirable from a public policy standpoint. In other words, the public would not favor the idea of adding prophylactic ingredients to the public water supply although it might be in entire accord with retaining "normal" iodine content of salt.

Arch Dam Planned for Test to Destruction

THE COMMITTEE on arch dam investigation appointed by Engineering Foundation has selected a site at which an arch dam could be built 50 to 100 ft. high, tested repeatedly, and finally loaded to destruction. Construction is to start as soon as sufficient funds have been received and an invitation to contribute is being extended to all who are interested in securing more information on the subject of arch dams, particularly information that would make for a reduction in the cost of such structures so far as is consistent with safety. Subscriptions totaling about $30,000 have thus far been pledged; it is hoped that a total of $100,000 can be secured for the investigation. Subscribers are offered every opportunity to have engineering representatives present during the tests and all data collected will be available for their consideration, subject only to the condition that publication of results shall be exclusively by the Engineering Foundation committee. Previous reference to the work of the committee was published in *Engineering News-Record* March 29, 1923, p. 598, and Nov. 8, 1923, p. 755.

The site selected for the test dam, which is on Stevenson Creek, a tributary of the San Joaquin River about 60 miles east of Fresno, Calif., has the following advantages: (1) Suitable foundation without an undue amount of stripping; (2) accessibility of location; (3) location upon "neutral" ground; (4) water available at will for conducting the test; and (5) reservoir capacity that will not be so large as to jeopardize life or property if the structure should actually fail.

The site is in a canyon which has the U-shaped section typical of many western dam sites and a streambed gradient of about 25 per cent; a 60-ft. dam would impound only about 10 acre-ft. A tunnel conveying water from Shaver Lake for power purposes passes near the site and an adit controlled by a valve would make it possible to fill the reservoir quickly.

The plan is to build a simple single-center arch dam with a constant upstream radius and a vertical upstream face. It is to be built of thin section and carried, at the outset, to a 60-ft. height, when repeated tests under various load and temperature conditions are planned for a period of about a year. The small reservoir capacity will make it possible to repeat measurements on the same or the following day so that temperature, water content of concrete and other conditions may be practically the same for each series of tests. The reservoir may be kept empty for a period of several months so that temperature changes in dry concrete can be measured, and at other times the reservoir will be kept full so that information may be secured on the "flow" of concrete, time factor and related problems.

After studies and analyses of this sort have been made as comprehensive as possible, the structure is to be raised successively in 10-ft. steps with tests at each stage until failure occurs or until the dam reaches the maximum height economical at this site, which would be 100 ft. or more.

The design of the dam, the tests and compilation of all data will be in the hands of the committee appointed for this purpose by Engineering Foundation. W. A. Brackenridge, senior vice-president, Southern California Edison Co., Los Angeles, has been selected by the committee to have charge of receiving and disbursing funds.

Large Concrete Flat Buildings Erected in Thirteen Weeks

Columns of Emperger Type—All Members of Uniform Size—Plant and Forms—Concreting Averaged Two Stories Daily

REMARKABLY rapid work was accomplished in the erection of two adjacent 16-story concrete buildings in Chicago a few months ago. All foundation and framework construction was carried out within 13 weeks. The purpose of this speed was to have the structures enclosed before cold weather, so that the interior work and finishing could be done during the early part of the winter and the buildings made ready for occupancy far in advance of the renting season. These buildings, Fig. 1, at Sheridan Road and Grace St., are 111 x 52 ft., with the width reduced to 40 ft. in the rear portion, and with a height of 173 ft. from sidewalk to roof. They are separated by a terraced garden court 46 ft. wide. In structural design they are notable for the use of the Emperger system of solid cast-iron cores and spiral wrapping in the columns and for the use of beam and girder floors instead of the ribbed slab type of floor with closely spaced joists.

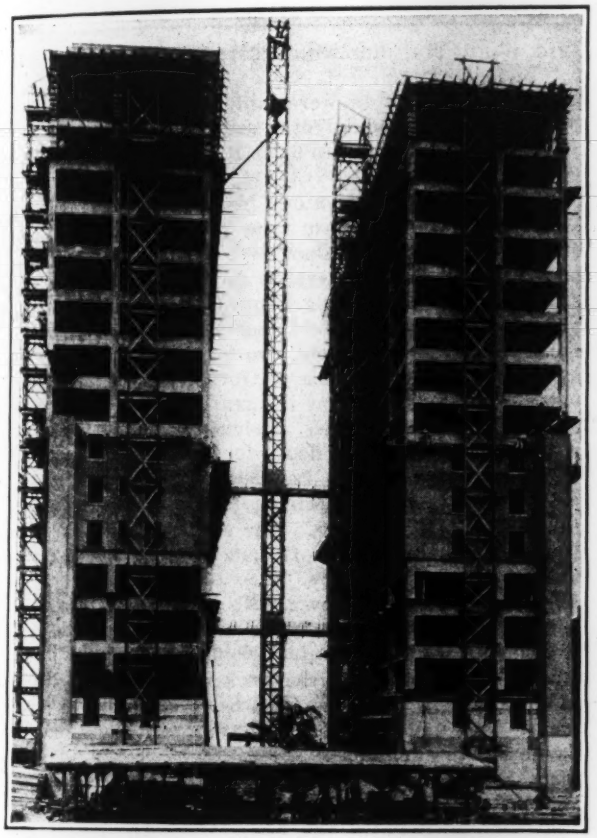


FIG. 1—CONCRETE APARTMENT BUILDINGS; AUG. 16, 1923

Brick material elevator on one side of each building. Slide elevators at ends. Carpenter shop in foreground. Stone for finish of lower stories was delayed. Note communication bridges.

Since the site is over a bed of gravel some 25 ft. deep no piling was needed and the foundations consist of spread footings for the interior columns and a continuous wall for the outer columns. This wall, 2½ ft. thick and 8 ft. high, with a 13½-ft. footing, is designed to act as a distributing girder and was cheaper than separate footings. The wider front portion of the building, where it abuts on the lot line, has six columns seated on a 24-in. slab 46 x 23 ft., resting on the gravel. These foundations were designed for a load of 4,000 lb. per square foot. A rich concrete, 1:1:2 mix, was used for the upper part of all isolated footings.

All the columns are 23 in. square from top to bottom, and consequently all girders, beams and lintels are uniform from story to story. This arrangement reduced the number and variety of forms and expedited their erection. The framing plan is shown in Fig. 2. The solid cast-iron cores for the columns reduce gradually from 8-in. diameter at the base to 2½-in. at the seventh floor, above which the standard spirally hooped concrete columns continue to the roof. The cores of interior columns are embedded in the footings, Fig. 3, where they are surrounded by spiral reinforcement. But the cores of the exterior columns rest on plates on the foundation wall, which is reinforced beneath them to provide for the diverging distribution of the load.

Floor panels are mainly 20 x 20 ft. and 17 x 20 ft. c. to c. of columns and are subdivided by beams of 6-ft. spacing, as shown by Figs. 2 and 3. The large area of slab resulting from this arrangement, as compared with a ribbed slab floor, is considered to simplify greatly the arrangement and erection of pipes and conduits for heating, plumbing and electric service. The depth of beams is 12 in., including the 3-in. slab. Since deep girders crossing the rooms would have been unsightly, the girders in many cases were kept at the same depth as the beams, the required strength being obtained by increased width and heavy reinforcement.

Because the buildings are high and narrow, ample reinforcement as wind bracing was provided at connections of wall columns and lintel girders and also at two intermediate planes between three columns. Reinforcing rods are of high-carbon steel, with hook ends. They were bent to shape at the mill, the steel being too hard for bending on the work. The floors are designed for a 40-lb. live-load.

Stone and brown brick are used for the exterior walls, but as there was delay in delivering stone the brickwork was started at the fifth floor while the lower floors were still open. To support the 4-in. projecting

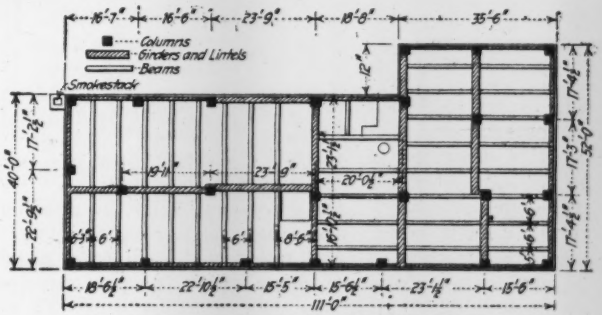


FIG. 2—FRAMING PLAN OF CONCRETE APARTMENT BUILDINGS

pressed brick facing of the 12-in. brick wall a ¼-in. plate, 12 in. wide, was placed on top of the lintel, with a projection of 4 in. beyond the concrete. This was much quicker and cheaper than drilling the lintels for the attachment of shelf angles. Across the faces of

the columns the brick facing is supported by angles 4 x 4 x $\frac{5}{16}$ in. resting on the ends of the $\frac{1}{4}$-in. plates.

Artificial stone was used for the decorative work and trim of the roof and upper floors. The cornice, 3½ ft. high, with 14-in. projection, was cast monolithically of white cement mortar. The roof is similar to the floors and is covered with tar-and-gravel composition roofing. Each building has a brick smokestack, which was found to be cheaper than steel; the interior arrangement made it necessary to build the stack on the outside instead of carrying it up through the floors.

A 60-car garage for the sixty apartments is a part of the work. It is a one-story structure 120 x 126 ft., of flat-slab construction. This garage adjoins the rear of the two buildings and is hidden from the street by the terracing of the garden court.

Complete design of forms in the engineer's office expedited the work materially. Every variety of form

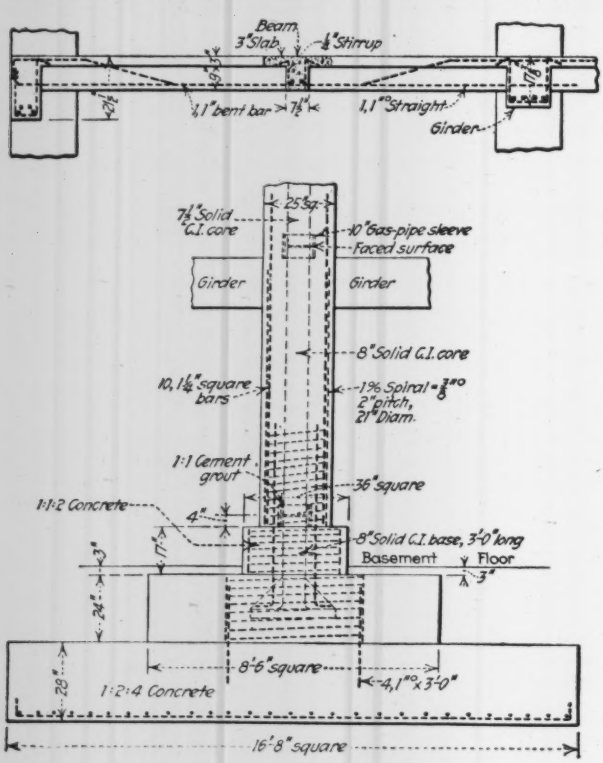


FIG. 3—COLUMN AND FLOOR DESIGN

was drawn in detail and marked for erection, with bill of material for each form, in the same way as steel erection drawings are marked. Thus nothing was left to the carpenter foreman except to see that the work was done according to the drawings, while the erection foreman knew exactly what forms to use for every part of the concreting. It was found that each form could be used about six times, after which it would require so much repair that it was cheaper to use a new form, the old material being utilized for various purposes, particularly for shed construction and wall forms on other work.

A single concreting plant having a mixer of 21 cu.ft. capacity and a bucket elevator tower with 50-hp. electric hoist was placed in the court between the two buildings. This plant delivered concrete to each building on alternate days. Concrete was chuted from the tower to a hopper on the floor for charging wheeled carts or buggies which delivered it to the forms. Each building was served by three material elevators, making six in all. In view of the rapid progress required,

FIG. 4—RIG FOR BREAKING TESTS ON SAMPLE BEAMS

all of these elevators were built and extended as the building rose, although ordinarily the brick material elevators are not installed until after the concrete frame is finished.

One of the three elevators, placed at the north long side, was of the platform type with a platform large enough for three wheelbarrows. At each end of the building was a slide elevator for such long materials as lumber and reinforcing bars. Ginpole derricks were also used in hoisting and placing the forms. Four hoisting engines were used, two for each building. One at the front operated the platform elevator, slide elevator and derrick; one at the rear operated the second slide elevator and ginpoles. Bridges spanning the court were built at different floors to facilitate passage between the two buildings (see Fig. 1).

Breaking tests of specimen beams were an important feature of the work. For each run of concreting four beams 4x6-in. and 8 ft. long were tested at intervals of about three days. The testing rig, shown in Fig. 4, consisted of a lever with arms 13 in. and 9 ft. 9 in. long, pivoted in a frame and loaded at one end. A roller formed the contact point on the test beam. By these tests made on the work it was easy to determine definitely how soon the falsework might be removed from under the forms, thus effecting considerable saving in the amount of falsework lumber. For complete assurance of strength, the bottom reinforcing rods of the test beams were placed on the bottom of the form, so that the full beam depth was known and there was no question as to the distance of the rods from the bottom of the beam.

Progress on the concrete work averaged two stories per week in each building, and in several cases the forming and pouring of an entire story was done in two days. On June 1, the foundations were completed and some column forms set. On June 8, one building had three stories and the other two stories poured. On July 13, both buildings were ten stories high and on Aug. 1 this had increased to 15 and 14 stories respectively. The roof of one was completed on Aug. 16 and that of the other on Aug. 18. This record is for the concrete frame only, the wall construction being carried on simultaneously. For the concreting, the force averaged forty men, working one shift of eight hours.

The structural design was prepared by L. J. Mensch, consulting engineer, Chicago, who also was the general contractor for the entire work. The architect was W. W. Alschlager, Chicago.

Relation of Sewer Trench Width to Load on Pipe

Wide Trenches and Poor Bedding Give High Loading—Definite Figures for Each Condition Make Rational Designs Possible

BY GEORGE C. D. LENTH

Consulting Engineer, Clay Products Association, Chicago; Formerly Assistant Chief Engineer in Charge of Design and Construction of Sewers, Chicago Board of Local Improvements

SOME YEARS ago there was conducted by Prof. Anson Marston, director of the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts at Ames, Iowa, an important series of research studies on the bearing strength of sewer pipe and drain tile. These investigations covered a period of several years and during their progress many phases in the methods of trench digging and pipe laying were studied. The principal or outstanding factors developed in this investigation may be summarized under: (1) Weight and character of soil used as backfilling; (2) depth of trench above the top of the pipe; (3) width of trench; (4) preparation of pipe bed, and (5) character of soil on which the pipe is laid.

For years past many engineers, because of a lack of proper appreciation of the stresses developed in a sewer structure, have not only permitted but required the contractor to so excavate the sewer trench that the corners at the bottom would be practically right angles and the bottom or floor of the trench a flat plane. When the present form of sewer pipe came into vogue, whereby the hub was made an integral part of the pipe, it was recognized that bell holes should be made in the bottom of the sewer trench, so that the weight of the pipe and backfilling above it would be distributed evenly along the barrel of the pipe rather than have the pipe act as a beam supported only at each end. However, no consideration apparently was given to the proper shape of the trench floor or how much of the lower surface of the pipe should be in bearing contact with the earth.

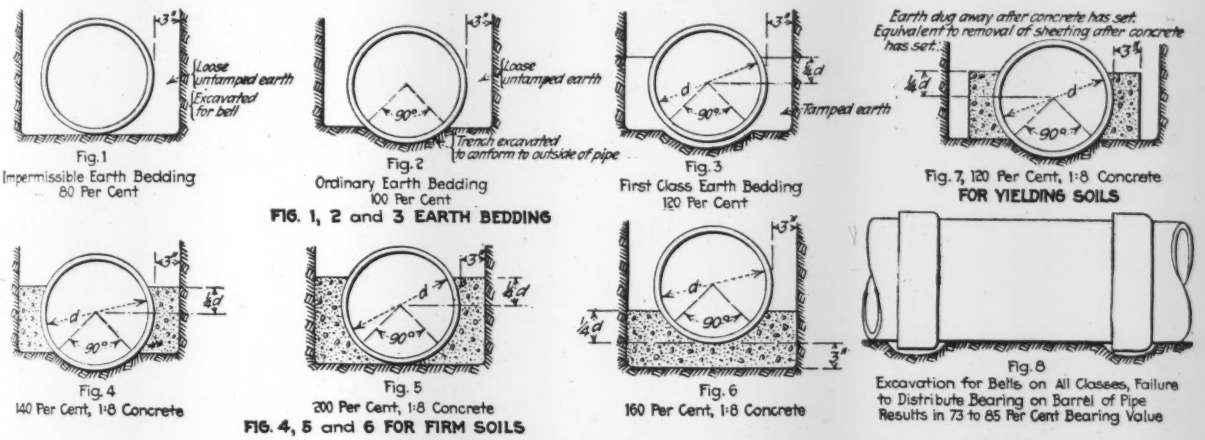
The weight of the backfilling produces a load on the sewer and a stress within the structure. The reaction through the structure acts in two directions: (1) vertically to the foundation upon which the pipe rests, and (2) horizontally through deformation in shape, to the adjacent sides of the trench. If the character and condition of the earth adjacent to the sides of the sewer structure is such that but slight, if any, horizontal deformation can take place, the structure will stand, but if this condition is reversed and excessive deformation is produced then failure naturally occurs for the reason that the masonry structure of the sewer is not an elastic ring or tube.

Impermissible Method of Laying—The experimental work conducted by Professor Marston proved conclusively that when a pipe was laid on a flat-bottomed square-cut ditch and the space around the pipe backfilled with coarse material without tamping, there was developed only 75 to 80 per cent of the supporting strength of the pipe and because of this fact this method of laying is termed impermissible for the reason it should never be permitted.

Ordinary Method of Laying—When the floor of the ditch is shaped to receive the lower quadrant of the outside periphery of the pipe and the space around the pipe is backfilled loosely without tamping, as illustrated in Fig. 2, then is the full 100 per cent bearing strength of the pipe developed. This manner of laying is called ordinary as it is about as good as ordinarily obtained.

First-Class Method—It is apparent that well consolidated earth will react more rigidly than loosely consolidated material and if the pipe is laid in a trench the bottom of which is formed to receive the lower quadrant of the pipe and the space under and around the pipe to a height equal to three-fourths of the diameter (Fig. 3) with selected granular earth material thoroughly tamped, an additional strength of 20 per cent over the ordinary method will be obtained. This type of construction requires first-class workmanship and careful inspection and naturally is called first-class.

Special Methods—Prompted by the results obtained in the earlier experiment, conditions which would require special treatment were studied. Fig. 7 illustrates a condition wherein 3 in. of 1:8 concrete is placed on each side of the pipe and a space left between the undisturbed soil and the sides of the concrete. This condition whereby a space is left between the masonry and the trench walls happens very often in practice on account of the necessity for the use of sheeting to support the sides of the trench during construction and the space is formed when the sheeting is pulled or removed after the pipe is laid. Experiments showed


Loose untamped earth
Excavated for bell
Fig. 1
Impermissible Earth Bedding
80 Per Cent
Loose untamped earth
Trench excavated to conform to outside of pipe
Fig. 2
Ordinary Earth Bedding
100 Per Cent
Tamped earth
Fig. 3
First Class Earth Bedding
120 Per Cent
FIG. 1, 2 and 3 EARTH BEDDING
Earth dug away after concrete has set. Equivalent to removal of sheeting after concrete has set.
Fig. 7, 120 Per Cent, 1:8 Concrete
FOR YIELDING SOILS
Fig. 4
140 Per Cent, 1:8 Concrete
Fig. 5
200 Per Cent, 1:8 Concrete
Fig. 6
160 Per Cent, 1:8 Concrete
FIG. 4, 5 and 6 FOR FIRM SOILS
Fig. 8
Excavation for Bells on All Classes, Failure to Distribute Bearing on Barrel of Pipe Results in 73 to 85 Per Cent Bearing Value

FIGS. 1-8—METHODS OF PIPE LAYING AND RELATIVE BEARING VALUES

that the pipe when supported with concrete in this manner developed a bearing value of approximately 120 per cent of the normal strength of the pipe, or a strength equal to the condition as shown in Fig. 3. If on the other hand there is placed 3 in. of 1:8 concrete between the sides of the trench and the side of the pipe as shown in Figs. 4, 5 and 6, so that no space is left between the undisturbed soil and the pipe, there

width of trench for each size of pipe? A formula which has been used by Metcalf & Eddy is:

Maximum trench width = 1.4 × pipe diameter + 12 in.

While it has been common practice for many engineers to specify that the maximum width of trench shall be such as will give a working space of 12 in. on each side of the pipe, it is my opinion that the maximum width of trench should not exceed four-thirds of the

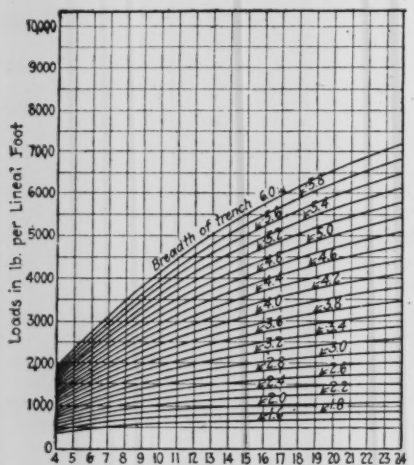


FIG. 9-PARTLY COMPACTED DAMP TOP SOIL
WEIGHT 90 LB. PER CUBIC FOOT

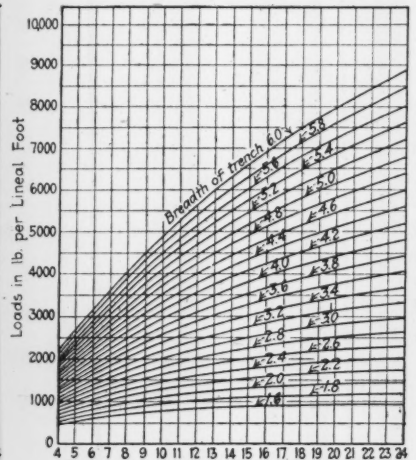


FIG.10-PARTLY COMPACTED DAMP YELLOW CLAY
WEIGHT 100 LB. PER CUBIC FOOT

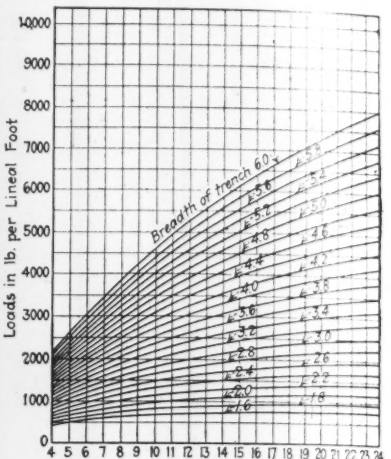


FIG.11-DRY SAND
WEIGHT 100 LB. PER CUBIC FOOT

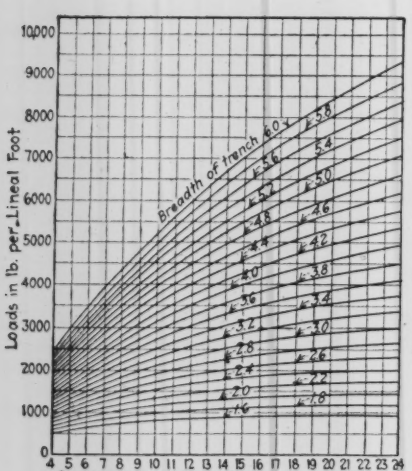


FIG.12-SATURATED TOP SOIL
WEIGHT 110 LB. PER CUBIC FOOT

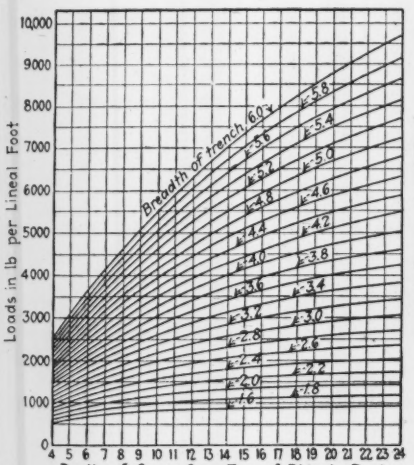


FIG.13-SATURATED SAND
WEIGHT 120 LB. PER CUBIC FOOT

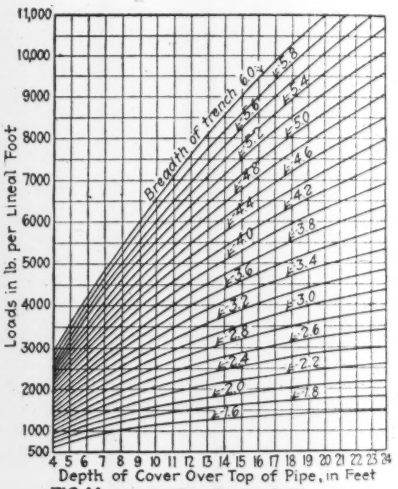


FIG.14-SATURATED YELLOW CLAY
WEIGHT 130 LB. PER CUBIC FOOT

FIGS. 9-14—LOADS IN TRENCHES OF VARYING WIDTHS, FOR DIFFERENT KINDS AND CONDITIONS OF SOIL

is developed a condition whereby the strength of the pipe is from 150 to 220 per cent of the normal bearing value as developed under the ordinary method of laying.

From this brief discussion it is apparent that to lay sewer pipe properly excavation for the bell holes and the lower 90 deg. of the pipe must first be made, and that it is advisable to tamp the earth or backfill around the pipe in order to develop something more than its full strength as a factor of safety.

The bell holes should be only large enough to fit the hubs of the pipe. Excessively large bell holes reduce the length of the bearing surface under the barrel of the pipe and thus permit an undesirable concentration of load on a comparatively short length.

The question which next arises is, What is the proper internal diameter of the pipe plus 8 in. The accompanying table shows the width of trench predicated on the various formulas or instructions above referred to. There is also added to this table the crushing strength of pipe as fixed by the American Society for Testing Materials.

Having determined the maximum width of a trench for sewer pipe, the practical application of the investigations as reported in *Bulletin* 31 of the Engineering Experiment Station, Ames, Iowa, may be illustrated by the accompanying diagrams (Figs. 9-14) which are a graphic representation of a part of Professor Marston's important contribution to engineering literature.

These diagrams are based on six different soil conditions, the lightest being 90 lb. per cubic foot for partly

compacted damp top soil and the heaviest 130 lb. per cubic foot for saturated yellow clay. The curved lines on the diagrams indicate widths of trench varying from 1.6 to 6 ft. and are computed from Professor Marston's formula $W = CwB^2$ wherein W is the weight or load on the pipe per lineal foot of trench, C = coefficient due to the soil condition, w the weight per cubic foot of the trench filling, and B the breadth of the trench measured just below the top of the pipe. As all of the diagrams are similarly constructed it is unnecessary to describe the use of more than the first by means of definite examples.

Let us assume that the maximum width of the trench for a 24-in. sewer pipe has been specified to be four-thirds the diameter plus 8 in. or 3.4 ft., and that the depth of cover over the pipe is 8 ft. Referring to Fig. 9,

MAXIMUM WIDTHS OF TRENCHES FOR SEWER PIPE

Size of Pipe In.	A.S.T.M. Crush. Strength Lb. per Lin.Ft.	Metcalf & Eddy Formula $1.4 + 12$ in. Ft.	Writer's Formula $4/3d + 8$ in. Ft.	Old Rule $d + 2t + 24$ in. Ft.
6	1,430	1.70	1.33	2.69
8	1,430	1.92	1.57	2.90
10	1,570	2.17	1.76	3.08
12	1,710	2.40	2.00	3.27
15	1,960	2.75	2.32	3.56
18	2,200	3.10	2.67	3.85
21	2,590	3.45	3.00	4.17
24	3,070	3.80	3.33	4.46
27	3,370	4.15	3.67	4.77
30	3,690	4.50	4.00	5.08
33	3,930	4.85	4.33	5.35
36	4,400	5.20	4.67	5.75
39	4,710	5.55	5.00	5.94
42	5,030	5.90	5.33	6.25

Note—d = internal diameter of pipe; t = thickness of pipe.

wherein the weight of the soil is taken to be 90 lb. per cubic foot, locate the vertical ordinate representing 8 ft. depth of cover, trace this ordinate upward to its intersection with the curved line marked 3.4 and project this point horizontally to the edge of the chart where it is found that the load is 1,700 lb. per lineal foot of pipe. If the width of trench is 4.4 ft. the load is 2,600 lb. per foot, and if, as is sometimes the case, an extremely wide excavation results from the use of a steam shovel or dragline machine giving a trench 6 ft. in width, the load per foot will be 3,800 lb.

From this example it is apparent that it is highly important that the maximum width of trench should be specified for all kinds of excavation, as in the case cited there was a variation of from 1,700 to 3,800 lb., representing an increase of 120 per cent in the load which must be sustained by the pipe.

Modern efficiency methods have brought about the use of excavating machinery of various types. In the early stages of sewer construction all excavation work was done by hand. At the present time excavating machinery of the endless-belt type is in use. With the design of the bucket used on such machines one may get the trench bottom dug to fit the lower quadrant of the pipe and if bell holes are dug it is safe to assume that there will be developed a 100 per cent condition as is shown in Fig. 2. However, with the use of the steam shovel and the dragline machine on this class of work, where large quantities of earth can be moved at a small cost and contractors prefer to dig the ditch wide and slope it rather than use sheeting, there then is introduced the additional hazard and likelihood of an extra wide trench which may spell failure and trouble for the engineer.

In the presentation of the diagrams in this form let it be understood that they are based on data given in various bulletins of the Iowa Engineering Experiment Station. The placing of the diagrams in this form is done with the thought of developing a more extensive use of the excellent and painstaking work of Dean Marston and his colleagues.

Checking Erosion and Clogging at Railway Culverts

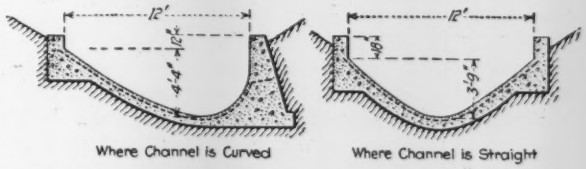
From the report of Committee on Roadway presented at the annual meeting of the American Railway Engineering Association.

IN PREVENTING culverts from becoming blocked in times of storm, the problem is to reduce the carrying capacity of the water, prevent erosion of the banks and bottom of the stream, or otherwise prevent flood deposits from reaching the culverts. Where the trouble is chiefly from driftwood and brush, a drift catcher constructed of old rails is very effective. The rails may be driven into the ground or set in concrete across the stream, with their tops properly anchored. After the storm, the drift material can be collected and burned.

A cheap and effective method employed by the Chicago, Burlington & Quincy R.R. to reduce the velocity of the water is the construction of tree dams. A heavy post was set in the center of the stream, with top and bottom anchored upstream. Trees were cut on the banks and the butts laid against the upstream edge of the post, the tops being allowed to press against the bank on either side, forming a V-shaped dam. The trees were alternated first one side and then the other of the stream. Sufficient of the limbs were then placed between the crevices formed by the spacing of the butts to about close the openings.

The dams were built three to five feet high, depending on the fall of the stream, the idea being to have the base of a dam practically level with the top of the dam next below it. There was sufficient rock below each dam to prevent washing of the stream bed. After the first heavy rain, each dam became filled with débris and the channel below the lower dam washed itself clean. No trouble has been experienced since, while before the installation it was frequently necessary to use a dragline or steam shovel to clear the creek after a heavy rain. A similar series of dams has been constructed with boulders.

Where material is deposited at the lower end of the culvert and gradually backs up until the entire opening is



DISCHARGE CHANNELS FROM RAILWAY CULVERTS

filled, this condition can usually be overcome by the construction of a conduit for a sufficient distance from the lower end of the culvert, thereby increasing the velocity of the water and carrying the material beyond the culvert. Designs for such conduits are shown in the accompanying drawing.

In a new method of protecting banks against erosion, known as the "angular submerged tree planting system," as tried on the Erie R.R., white willow poles were planted in shallow trenches plowed or dug across the valley at intervals of 10 or 12 ft. For the banks, holes were made at the foot of the bank at intervals of 2 to 5 ft. with a bar and a shallow trench made in the slope; the pole was then thrust into the hole or trench and covered lightly. White willow was selected as it will grow in almost any soil where there is water and will form a deep and dense root structure. The planting was done in March, 1923, and a vigorous growth from the poles was evident in June, some shoots reaching a length of 2½ to 3 ft. As the root structure of this plant is about five times as extensive as the shoots, there is every reason to believe that this experiment will be successful.

How the British Railways Were Consolidated: 1921-1923

Brief Period Allowed for Compulsory Action Proved Ample—Few Disputes—Four Regional Systems—Financial Plan

CONSOLIDATION of all the railways of Great Britain into four great and mainly non-competitive systems was projected, discussed, planned, worked out and accomplished as to its legislative, financial and operating stages in the short period of rather less than two years, 1921-1923. The following review of this procedure is compiled from the recent book by W. E. Simnett on "Railway Amalgamation in Great Britain."

Consolidation or amalgamation began early in the history of railways, both in England and America, and has been a continual process, as companies owning connecting lines have been gradually absorbed and combined under various legal and financial methods. In 1921 the British railway system of about 20,000 miles, with 50,000 miles of track, was owned by only 120 companies, exclusive of certain joint lines and light railways. And of these only fourteen were large companies, of which three were in Scotland. Up to 1914, the government regulation of railways had included no legislation presenting a policy in regard to railway combination, but there was legislation providing for government control in case of war. On the outbreak of the World War the railway system was put nominally under the control of the government, the actual control being in the hands of a board composed of railway managers. This board was dissolved at the end of 1919, a bill having been passed creating a minister of transport, but all government control (except that of supervision and regulation) ended in 1921.

Recent Consolidation—In 1918, a parliamentary committee presented conclusions favoring "further amalgamation of railway companies, either under private or government ownership." No action resulted from this. But in June, 1920, the government proposed the consolidation of all railways into seven groups, one of which was for Scotland and another for all lines in the London district. Eventual compulsory amalgamation was included. The project did not meet with approval, but it formed the basis of the final plans embodied in the Railways Bill, which after some amendment became a law on Aug. 19, 1921, four days after the close of the War period of government control.

The Railways Act of 1921, under which the consolidations were actually effected, is less drastic than the original bill and represents a large amount of agreement and compromise between the government, the railway companies, the trading community and the trades unions. It provides for four companies, each composed of a few larger or "constituent" companies and a number of smaller or "subsidiary" companies. The act dealt with 120 companies, of which 93 were subsidiaries. It created an amalgamation tribunal, composed of three commissioners, to supervise the carrying out of the provisions of the act.

For each group the constituent companies were required to submit an amalgamation scheme to the Minister of Transport by Jan. 1, 1923. By this same date the constituent companies of any group were to submit a scheme for absorption of the subsidiary companies of that group. All these schemes were to be submitted to the amalgamation tribunal for approval, but were first to be submitted to the proprietors and stockholders of each company. In the event of failure of any group to comply with these requirements, the tribunal was empowered to prepare a scheme, but this alternative proved to be unnecessary.

All the amalgamation and absorption schemes were to go into effect on July 1, 1923. Since the tribunal did not commence work until late in November, 1921, the railways had only about eighteen months in which to reduce their number from 120 to four. As a matter of fact, however, the greater part of this task was accomplished well within this period, and the four new companies (though not completely constituted) were actually operating from the beginning of 1923 (see *Engineering News-Record*, April 5, 1923, p. 616).

The short time limit and the compulsory features of the act did not receive universal approval, even after its passage. In fact, a movement was made early in 1922 to extend the time and to annul the element of compulsion, but this came to nothing. Various powers are given to the Minister of Transport in regard to operation, facilities, service, standardization and other matters. Furthermore, the four amalgamated companies are prohibited from entering into any agreement for pooling or combination except under the authority of the minister.

Financial arrangements were left for the companies to negotiate, under supervision of the tribunal, but most of the disputes were settled without the necessity of referring them to the tribunal for decision. Mr. Simnett states that the difficulty of equalizing the varying financial strength of different members of a group was solved by grading the stock of the new company. There was first and second guaranteed stock, first and second preference stock, and ordinary stock split into a 5 per cent preferred and a deferred ordinary stock. The total capitalization represented is over $1,740,000,000 and it is said "the terms were well received in financial circles."

Four English Systems—Under the present organization the entire railway system is now distributed as follows: London, Midland & Scottish Ry., with 7,790 miles of line and 19,000 miles of track, including sidings; London & Northeastern Ry., 6,500 and 17,500 miles; Great Western Ry., 3,800 and 8,750 miles, and Southern Ry., 2,200 miles of line and 5,400 miles of track. Although the division is territorial or regional, the territories of these lines overlap considerably, so that there are several competitive routes, but the Southern Ry. has a considerable proportion of its territory to itself.

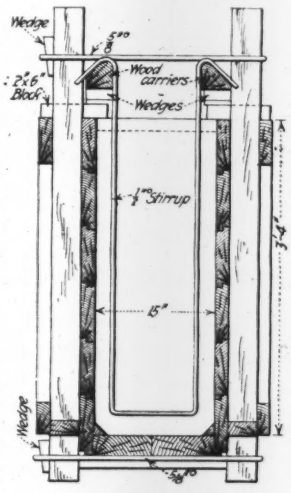
Government ownership of British railways without government operation is foreseen as an eventual and final step by Mr. Simnett, who suggests that all railway stock will then be acquired and paid for by some equivalent in government bonds. Then the problem of management of the one comprehensive system may be solved by the appointment of a single board of directors, entirely independent of political influence. This board would be "representative of the principal interests concerned with the railways, including the railway staffs of all grades and the general traveling public." There are no indications, however, that any such step will be taken until after a long term of years.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Wood Carriers Aid in Handling Steel for Precast Beams

IN THE construction of pier 4 at the U. S. Navy yard at Bremerton, Wash., described in *Engineering News-Record*, March 13, p. 436, a plan for using wood carriers was evolved for assembling and handling the steel reinforcement for the precast beams. This scheme worked well; it cut the cost of handling the steel to less than half the usual cost on "poured in place" construction and as the steel cages could be made up at any time and a considerable number could be made in advance, this work served to take care of odd time which would otherwise have been more or less wasted.

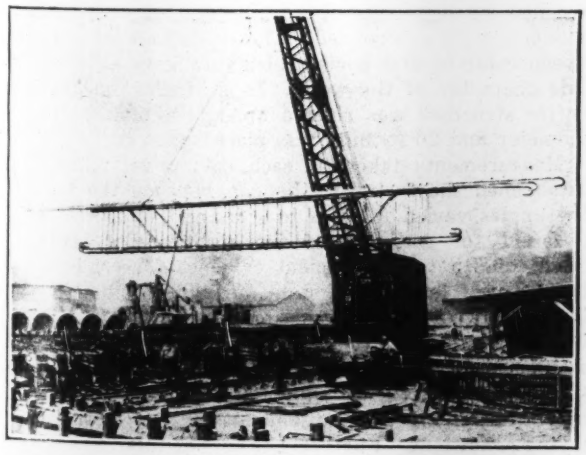


CROSS-SECTION OF FORM WITH STEEL IN PLACE

The steel was assembled on and fastened to two 4x4-in. carriers, 28 ft. long shaped to fit the hooks on the stirrups. When the forms were ready, these "cages" or frames were placed in them by a locomotive crane. The 4x4 carriers then rested on blocks along the forms spaced about 4 ft. on centers. This automatically and accurately spaced the steel without the use of spacers, thus assuring the desired thickness of concrete covering for all reinforcing.

To facilitate the work and to insure uniform and accurate spacing of the stirrups the 4x4-in. carriers were permanently marked and painted for each stirrup location. These carriers were supported on horses at both ends and the stirrups spaced according to locations marked, the main steel was then placed and wired to the stirrups. Cages assembled in this way proved to be rigid and easily handled by the locomotive crane.

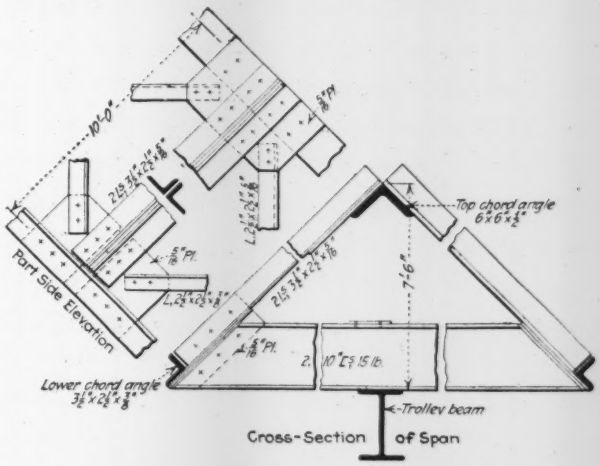
The details were outlined by the contractor and the work was sublet to W. F. Slezak, steel contractor of Seattle.



STEEL CAGE ASSEMBLED ON WOOD CARRIER

Shop-Yard Bridge of Triangular Section

A THREE-CHORD bridge to carry a shop-yard hoisting trolley runway has been built at the plant of the S. A. Chapper Iron Works, Detroit, according to a design by Adams & Adams, consulting engineers, of that city. The details of construction of this triangular bridge work out very simply, as the drawing herewith indicates. The bridges are economical, and are said to be rather stiffer than ordinary two-truss structures.



CONSTRUCTION OF TRIANGULAR BRIDGE

Bearing Tests Made on Ditch Bottom Facilitate Dragline Work

BY R. W. CROPPER
In Charge of Construction, Spring Creek Drainage District, Kankakee County, Illinois

SPRING CREEK Drainage District of Kankakee County, Ill., recently let the contract for cleaning its ditch, which had been dug some twenty years ago with a floating dredge. The ditch has a flow of water ranging from a minimum of 3 sec.-ft. in dry times to 50 sec.-ft. after rains. It drains a very sandy soil and in the twenty years had filled in on an average of 4 ft. with silt and sand, solidity of which varied from fluid to a hardness approaching sandstone. The waste banks, left by the floating dredge, had never been disturbed nor leveled by the farmers.

A 1-yd. dragline with continuous tread was selected for the work. It was necessary to move and level all the waste bank on one side, or, as an alternative operate

the dragline from the bottom of the ditch. This was possible only where the nature of the fill would sustain the weight of the machine. To determine the location of these places a staff was made whose bottom surface gave a bearing per square inch 25 per cent greater than that required by the machine. The staff was made of wood with a short cross member 12 in. from the bottom for a footing for the man making the tests. When bearing tests were made the man merely stepped up onto the cross member. At those places along the ditch bottom where the solidity of the fill sustained the man's weight on the staff without sinking to the cross piece, it was considered solid enough to sustain the machine's weight. At these places stakes were driven and the machine put into the bottom of the ditch as staked.

Since it consumed from 20 per cent to 40 per cent of the total working time to remove and level the waste bank, a considerable saving in cost was accomplished and by reason of the tests the machine was never mired. This one result alone was particularly desirable as much of the formation was quicksand.

R. D. Gregg was engineer for the district; Fred C. Morgan, contractor; and R. W. Cropper in charge of construction.

Correcting Defective Water Tower After Faulty Erection

By S. E. Berkenblit
Structural Engineer, Chicago

AMONG THE trying experiences of an engineer is the necessity of determining the safety of a structure whose erection is not in strict accordance with the design. Such an experience occurred with an 84-ft. steel tower designed by the writer to support a 60,000-gal. tank. In this tower, shown in the accompanying drawing, the legs are vertical and 18 ft. c. to c. to a height of 48 ft. 2½ in., and have then a slight batter which reduces the spacing to 13½ ft. at the top.

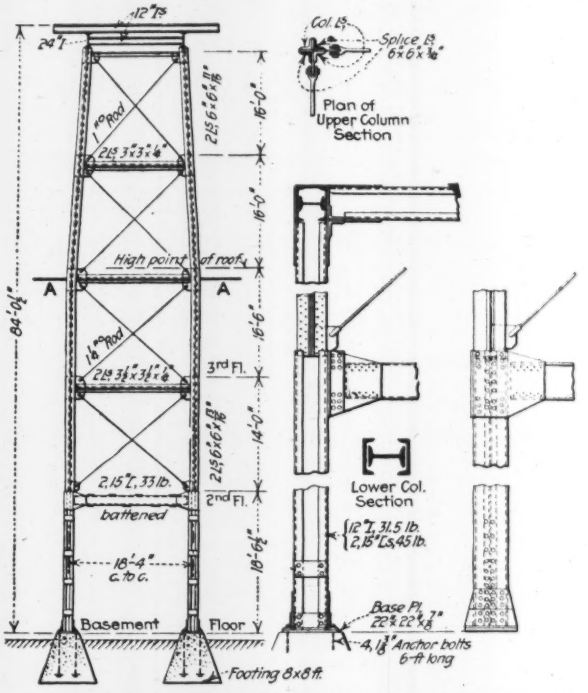
The vertical portion of the tower is inside a factory building and as the general layout made it necessary to omit diagonal bracing in the bottom bent, this bent is designed as a portal. In the upper portion of the tower each column is of star section, composed of two angles, as shown. In the portal bent each column is composed of a 15-in. I-beam and two 15-in. channels, with batter plates over the flanges of the channels. This design is such as to carry the load of the star column through the web of the I-beam and to give the required rigidity for wind stresses in both directions. Before shipment the material was inspected and checked to the satisfaction of all concerned.

A local contractor erected the tower and tank complete, without engineering inspection or supervision, and it was not until considerable trouble developed that the writer was called upon to inspect the tower. The most serious defect discovered was that at plane *A-A*, where the batter of the upper portion begins, none of the top or batter columns were in abutting contact with the lower or vertical columns, all load being transmitted through the splice plates. Direct contact of the column sections was a basis of the design and fabrication. The column ends were carefully milled to an even bearing and the riveted connections at this plane were designed for half of the maximum stress in the columns, in accordance with the Mutual Fire Underwriters specifications.

From Job and Office

Hints that Cut Cost and Time

Careful measurements revealed the fact that the concrete footings were put in at 90 deg. off the tower layout as shown on plan, and in such a way that when the tower was turned 90 deg. to fit these footings, the anchor bolts did not fit the column bases by considerable amounts. In erection, the bolt holes in the bases were enlarged to partly remedy this condition until some kind of fit was arrived at, and the columns when erected were about ¾ in. off the actual spacing dimensions called



WATER TOWER WEAKENED BY CARELESS ERECTION

for on the plans. As a result much hammering and drifting was resorted to take up this error at the bases of the columns, so that by the time plane *A-A* was reached, no semblance of a tight joint between column sections could be expected. The riveted connections between columns and horizontal struts gave evidence of this character of the work. In a similar fashion the entire structure was riveted up, and a tank 24 ft. in diameter and 20 ft. high was placed upon it.

Measurements taken at each column on plane *A-A* established the fact that the gap between the legs of the angles varied from ⅛ to ¼ in. and was practically different for each leg of the eight angles involved. Such condition was sufficient evidence for condemning the tower if left in this state during the filling of the tank. It would have been exceedingly difficult, if not impossible, to strengthen the riveted connections at this stage. Such work would necessitate either dismantling the upper portion or supporting it at considerable height, involving a great amount of field work under trying conditions. Further, the cost of this work would be prohibitive in relation to that of the structure. On

From Job and Office

For Contractor and Engineer

the other hand, a mere welding of the joints would not be a correct solution of the problem, since the welded material could only be considered as a filler without initial stress when put in place.

A method of "shimming and filling" was resorted to by the writer as the only alternative within the limits of cost. A number of steel plates or shims of thickness varying by ⅛ in. were selected and successive shims were carefully driven in the gaps between the ends of the angles, until a tight driving fit was obtained for as large a portion of the area as possible. As the gaps differed in each case this was a difficult task. At least 65 per cent of the total cross-sectional area of the column was successfully shimmed and as the riveted connections were to carry at least 50 per cent of the load, it was considered that the structure was then safe for filling the tank.

After the shims were driven, an acetylene torch was applied and they were carefully welded at corners and all around to unite them with the columns and thus insure their permanent position in the structure. The tank was then filled and the structure given a fair test. This tower and tank have been in service for over a year and no further trouble is anticipated.

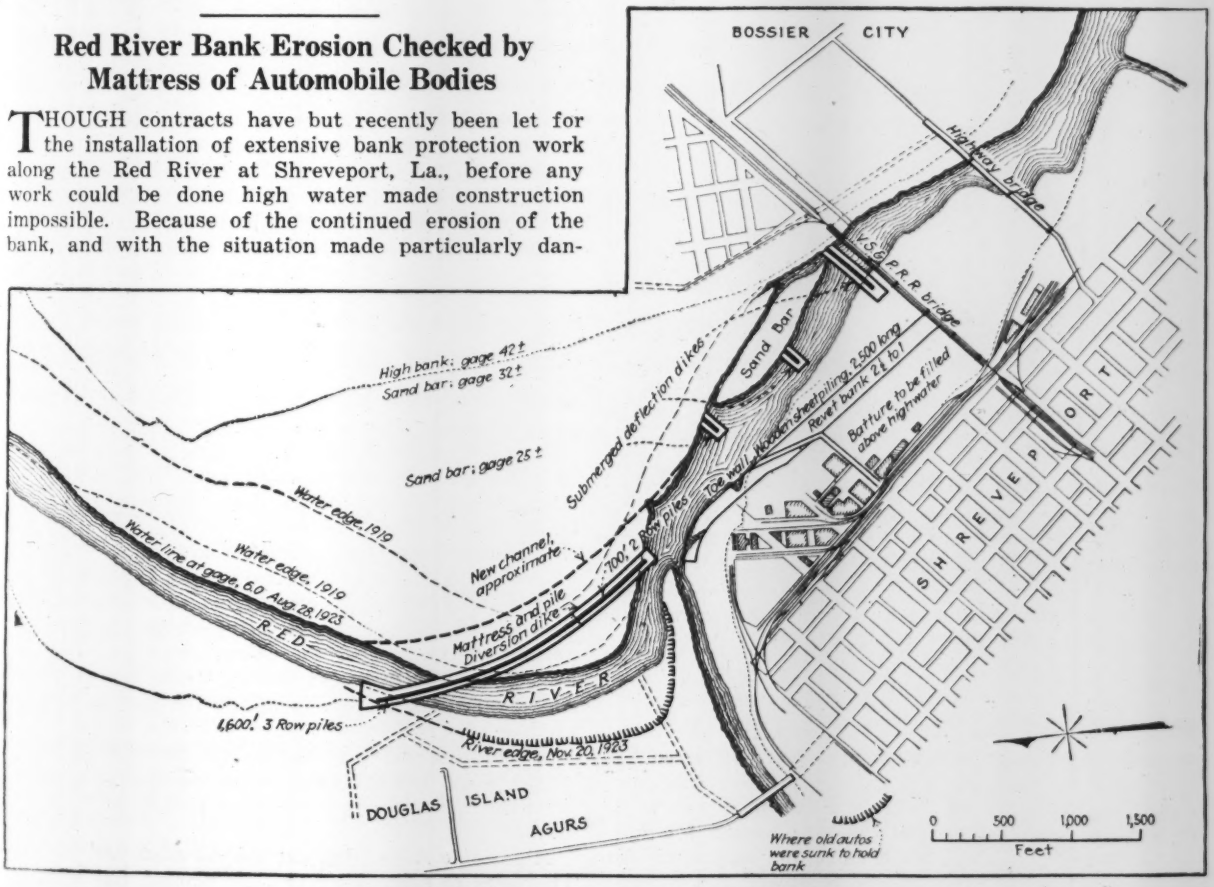
Red River Bank Erosion Checked by Mattress of Automobile Bodies

THOUGH contracts have but recently been let for the installation of extensive bank protection work along the Red River at Shreveport, La., before any work could be done high water made construction impossible. Because of the continued erosion of the bank, and with the situation made particularly dangerous through repeated rises in the river during December of last year and January of this year, temporary measures were necessary in order to avoid possible destruction of considerable valuable industrial property.

The city had retained C. E. Smith, consulting engineer of St. Louis, Mo., to co-operate with City Engineer H. E. Barnes in solving the problem of river control as well as reclamation of a large area for industrial uses. This system of bank protection consisting mainly in mattress and pile diversion dikes is shown in the accompanying drawing. The extent of erosion between 1919 and 1923, and the extraordinarily rapid erosion between August and late November, 1923, are also indicated.

Temporary relief was secured by the use of approximately 2,000 discarded automobile bodies which were spread over an area of about 40 acres near the industrial section of the city. The bodies were hauled to the point along the bank where they were to be submerged by 20 mule teams. Some 2,000 ft. of bank was thus protected with the abandoned cars. The auto bodies were thrown in water 20 to 40 ft. deep and in those instances where there was a possibility of their floating away were filled with rock and sunk.

Erosion of the bank has at the most dangerous point been thus effectively checked and there is little likelihood of serious damage being done before the permanent diversion dikes can be installed, as planned, in the spring.



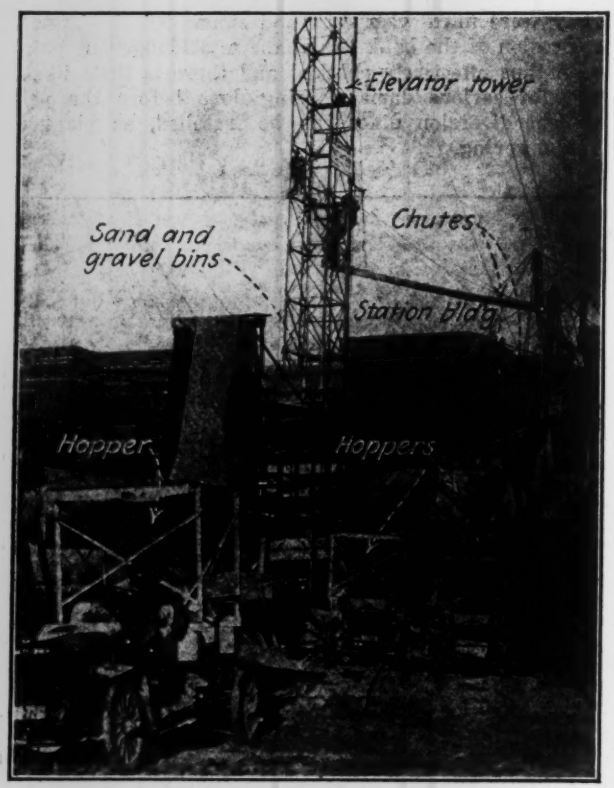
VICINITY MAP SHOWS BANK EROSION AT SHREVEPORT

Efficient Concreting Regains Lost Time at St. Paul Union Station

WITH RAPID construction made practicable by labor-saving equipment, careful planning and three 8-hour shifts daily, a delay in starting the 1923 program on the new Union Station at St. Paul, Minn., was not only overcome but the work was advanced two weeks ahead of schedule. This construction included an extension of the concourse and the second six-track section of the elevated deck.

Although the contract was awarded in March and it was expected to begin work in April, numerous obstacles prevented the contractor from getting fully under way until June 14. The work was at once organized on a 24-hour basis with a force of 300 to 350 men in three 8-hour shifts. The two night shifts cleared the ground, set the forms and placed reinforcing steel. The day shift poured the concrete. In this way an average of 22 tons of steel was placed in eight hours and 400 cu.yd. of concrete was poured daily during August.

Traffic conditions formed the most serious problem, since the structure stands between the wholesale district and the Mississippi River, and work had to be carried on without interrupting street traffic or the heavy railway business of the station. There was practically no space available except that which was to be covered by construction, and this was useless for storage purposes. In fact, the cement and aggregate for 25,000 cu.yd. of concrete had to be stored and handled on a space about 250 x 80 ft.



CONSTRUCTION WORK AT ST. PAUL UNION STATION
Stockpiles at left and bins over concrete mixer in front of elevator tower. Where concrete could not be spouted in place it was spouted to hoppers for loading into motor trucks.

Facilities for rapid handling of the aggregate overcame this difficulty. Sand and gravel brought in on cars were unloaded to stockpiles with a locomotive crane. A horizontal conveyor moved the sand and gravel to a vertical conveyor which delivered them to storage bins built above a 1-yd. concrete mixer, as shown in the accompanying view. Chutes in the bottoms of the bins opened above the batch hopper which measured the aggregate. Cement was wheeled out from box cars or the store house and spread over the sand in this hopper. The dry batch was then dumped into the mixer through a trap and at the same time the correct amount of water was added from a tank. While this batch was being mixed the operator filled the batch hopper and measured the dry cement for the next charge.

The concrete was discharged into a bucket, hoisted in a 160-ft. steel tower and dumped into a receiving hopper, from which a 200-ft. chute carried it to hoppers on the slab floor of the structure. One of these hoppers charged three narrow-gage side-dump cars; a gasoline locomotive then pulled the train along the edge of the work to charge other hoppers from which men wheeled the concrete in buggies to the footings. The other hopper, at the foot of the chute, was high enough to load three 1¾-ton trucks having 1-yd. hopper bodies, which carried the concrete across the slab deck to the farther edge, where the new slab was being poured. The retaining wall footings at the extreme outer edge of the work, too far away to be reached conveniently from the main mixing plant, were poured by a portable mixer.

A gasoline shovel dug out the old piers and footings. The piers of solid concrete were blasted, but the stone masonry and old cement floors were torn out directly

From Job and Office

Hints that Cut Cost and Time

18-Ton Tank Moved Over City Streets

THERE is shown in the accompanying illustration a 70,000-gal. steel riveted tank which was recently trucked from the Baltimore & Ohio yards at 26th St. and 12th Ave., New York City, to the plant of the Ballard Oil Co., 46th St. and East River. The tank was craned onto the truck, which had a special body built for moving such heavy loads. The body is made of 10x12 timbers, and has a wheelbase of 53 ft. when extended. The tank weighed 18 tons, had a length of 41½ ft., and a diameter of 10½ ft. It was fabricated by the Sisterville Tank & Boiler Works, Sisterville, W. Va., and trucked from the B. & O. yards to its position by the R. Doughty & Sons Co., New York City. After placement on the truck, the center of which rested practically over the rear axle, the tank was tied to the body of the truck in front with a steel cable and turnbuckle.

From Job and Office

For Contractor and Engineer

with the shovel. By a change of booms the crawler shovel was converted into a crane with a clamshell bucket to start the holes for new pier footings. As fast as excavations were ready the forms were set for the concrete, the crane raising the heavy forms and column heads. With the clamshell bucket this crane also placed the sand and gravel backfilling around the finished piers.

The chief engineer of the St. Paul Union Depot Co. is Col. Frederick Mears, who succeeded the late W. C. Armstrong; G. H. Wilsey is principal assistant engineer; W. B. May, assistant engineer; and C. P. Bohland, chief inspector. The contractors are Foley Brothers, St. Paul, whose chief engineer is D. A. Daly.

Breaking Up Ice with Pneumatic Tools

WITH LABOR so high and hard to find for such employment as breaking up ice formed in street gutters or breaking frozen earth, a new use has been found for pneumatic tools. As shown herewith employes of the city of Buffalo, N. Y., are freeing the gutters of ice with ordinary paving breakers operated from portable compressors. The picture was supplied by the Ingersoll-Rand Co., New York.

Economical Gravel Screening Plant at Rimrock Dam

ADVANTAGE taken of the topography at Rimrock, Wash., where the Bureau of Reclamation is constructing an earth and rock-fill dam with a concrete corewall has permitted rapid and economical production of screened gravel. In the March *New Reclamation Era*, the new name for the former *Reclamation Record*, the following data are given:

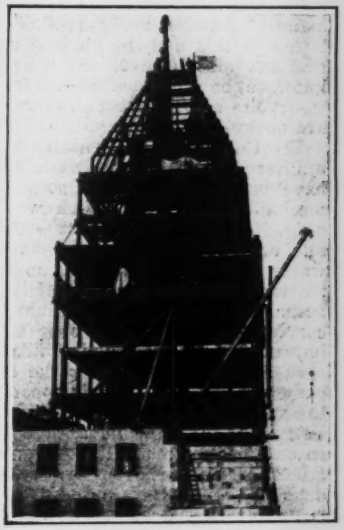
The plant, which is surmounted by a high cableway tower, is located at the center of a semi-circular arc described by the river in its course. The gravel is picked up from the bed and edge of the stream by a bucket suspended and operated along a cableway, one end of which is at the center of the tower, the other end being attached to a tree across the river. The gravel is dumped into a hopper at the top of the tower and is screened and washed in the same process.

F. T. Crowe, the construction engineer, who has had much experience along these lines, states that this is the most efficient and satisfactory gravel plant he has ever operated. It will excavate, screen, crush and wash approximately 400 cu.yd. per 8-hour shift with a crew of three men; 4-yd. cars can be loaded under the bins at the rate of one per minute by the brakeman on the train that conveys the material to the mixer.

Every considerable rise in the river refills the excavated portion of the gravel beds, so that the plant might be operated indefinitely and will, in fact, be operated several years from the same position.

Rapid Progress Made on 32-Story Office Building at Chicago

PLACING 12,000 tons of structural steel in 214 days (inclusive of Sundays and holidays) and five days ahead of the scheduled date of completion is the record made on the 32-story Straus Building, Chicago. Ground for this building was broken on March 21, 1923, and the deep foundation piers were completed June 23. The first steel column was placed July 16, and the last beam of the tower on Feb. 14, 1924. This final step is indicated in the accompanying view, which shows the guyed derrick for steel erection, and a breast derrick and stiff-leg derrick for placing the stone facing.



PLACING LAST BEAM ON TOWER OF 32-STORY BUILDING

An unusual feature in this building, as described in *Engineering News-Record*, Nov. 15, 1923, p. 794, was that the contract for steel fabrication was divided between seven companies, since no one concern could furnish the total amount with sufficient rapidity for the completion of the building by the required date. One mill supplied all the steel and one contractor did all the erection, while the fabricating concerns were required to conform to a definite schedule for delivery of material.

Rapid progress of the masonry walls accompanied the steel erection; on Feb. 8 the stone and brickwork of the 22-story main portion of the building was completed and had been started on the 10-story tower. By Feb. 20, the tile arch flooring had been completed to the twenty-eighth floor, the partitions were practically finished throughout the entire main structure and the marble work of the corridors had been completed to the fourteenth floor. The offices are to be ready for occupancy by May 1.

Both the architectural and engineering designs were prepared by Graham, Anderson, Probst & White, Chicago. The Thompson-Starrett Co. had the general contract and erected the steel; Archer & Son placed the stone work. The building is owned by the S. W. Straus Co., which will occupy six stories for its own business.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Reservoir Stripping at Birkenhead

Sir—The editorial in your issue of March 13, p. 435, under the caption: "A Costly Mistake," is on the face of it open to the most severe criticism. You have taken the adverse opinion of a non-technical person on a very technical subject in a very special case, without any knowledge of the circumstances under which the opinion was given and have drawn conclusions which are entirely at variance with the facts and entirely at variance with the opinions of those who carried the responsibility of that work.

The circumstances are well known to me, as most of the detail work which led up to the Alwen scheme being adopted for the supply of Birkenhead, England, were under my direct observation while acting as chief assistant to the engineer of this scheme, the late Dr. G. F. Deacon, and his successors, Sir Alexander Binnie, Son & Deacon, whose experience and knowledge of this particular kind of work are beyond all question. The report of Allen Hazen and George W. Fuller on the stripping of the Catskill reservoirs to which you refer was very carefully studied before any decision was made. Likewise, every available source of information relating to this and the kindred subject of mechanical filtration was also studied. As it appeared then—and as I now know to be the case by actual observation—the Catskill reservoirs and the Alwen reservoir situations in this respect are entirely different.

The Catskill water contains very little color and remains unfiltered to this day, while the Alwen water could not have been possible as a source of water supply without mechanical filtration which was intended from the beginning. The amount of peat within the Alwen reservoir site and on its drainage area was very considerable, and the water draining from it was so highly charged with organic matter that the treatment of it by mechanical filtration by actual experiment, using alum with and without alkaline correctives, was found to be exceedingly difficult, and the improvements in mechanical filtration since have not been of such a nature as to alter the case. It was only the very easy and simple reservoir construction, taking into account the removal of the peat to reduce the possible contamination by it, and the advantage of long storage in a clean reservoir, that made the Alwen site at all a desirable one. I feel certain that even Mr. Jackson, whom you quote, would have had an entirely different story to tell if that peat had been left in the reservoir, for it is quite likely that mechanical filtration would have failed or other equally or more costly expedients would have had to be adopted to pretreat the water.

People who look back 14 years sometimes are in as difficult a position as if they tried to look forward the same amount of time because there is often much essential matter hidden from view. The increased reservoir capacity brought about by the removal of the peat amounted to 220 U.S. m.g., equalling 26 days' supply to Birkenhead, and is, in itself, of considerable value to the scheme in making full use of the drainage area. At least one-half of the entire reservoir site was covered with peat running up to 20 ft. in depth or more, but of this only the intermediate and nearer parts to the dam and outlet works were removed, the remainder being isolated by a small dam to prevent floating masses of peat being carried to the intakes. Experience elsewhere not many miles distant had shown that in the early days of the reservoir large masses of peat had floated up, causing very considerable difficulties not to say much heart-burning and condemnation; and as the situation at the Alwen site was much worse, this point had much to do with the advice given to remove it.

From the beginning it was intended to treat this water by mechanical filtration, but it was estimated that the saving in chemicals and in the cost of maintenance and the increased reservoir capacity would more than compensate for the cost of removal of the peat and it is more than likely that this has been the case.

Further, the increased cost of the work, said to have been due to delay through the removal of the peat, must be a mistake. If there was delay in carrying out other parts of the work it could only have been through some arbitrary decision which has no bearing on the matter. The removal of the peat, although carried out under the same contract as the dam, in no way interfered with the carrying out of the other parts of the work.

WILLIAM GORE,
Toronto, Ont., March 18. Consulting Civil Engineer.

[We are pleased to put on record Mr. Gore's statements indicating that the Birkenhead scheme was carried out in the light of full engineering studies which took into account not only the Hazen-Fuller report on reservoir stripping but also the possibilities of mechanical filtration. In that respect the Birkenhead scheme seems to have differed from common British practice but in view of Mr. Gore's criticisms we will not be too positive on that point.—EDITOR.]

Concerning Concrete Roads

Sir—In *Engineering News-Record*, March 6, 1924, p. 418, Troy Carmichael discusses the articles on the reinforced-concrete paving which were published in *Engineering News-Record*, Jan. 10, 1924, p. 78. He also goes into a general discussion of the subject of concrete as a road surfacing.

Certainly Mr. Older and Mr. Goldbeck are well qualified to discuss the subject of reinforcement and design of road slabs and I consider that their remarks are well taken. The conclusion is that no tests have yet been devised which are complete enough to base scientific design upon.

As to Major Besson's statement in his "City Pavements" I believe he is speaking of city street paving which is quite a different matter from the concrete highway, however, even in that event certain provisions for reinforcing and for expansion and contraction may be necessary.

I must admit that there is a lack of uniformity in the use of joints, however, the trend seems to be toward a happy medium, experience having shown that joints need not be made every 30 ft. but that they may be required in less than a day's run. The longitudinal joint has justified its use as a divider of traffic alone whether it happens to be scientific or not.

Mr. Carmichael says there is a lack of progressive construction which applies principally to the more thickly populated sections. His idea is to start with dirt and build all the different types up to asphaltic concrete. I wouldn't want to be a taxpayer and have that happen to me. In some parts of New York state and elsewhere something like that has been tried and the trouble is that now it is impossible to catch up with traffic. It is true that a good foundation is necessary for best results but it can be obtained in a less expensive manner. I do not mean to condemn economical construction and the use of lower types where they are justified but the lower types are being found inadequate in the densely populated districts, which is the principal reason why so many people have put their faith in concrete.

Mr. Carmichael further states that concrete is an unproved pavement and of very doubtful value but he seems to think that any kind of resilient pavement would have many years of life if placed on a real good foundation. It is a fact that a thin black top on a heavy foundation will give excellent results but as a matter of fact in many localities that sort of construction would be more expensive than concrete. It is true that no first-class concrete pavement has ever worn out yet so we cannot tell what length of life to give it, but I think it is generally agreed that the rate of wear compares very favorably with many of the higher types in present use. And in most cases it will be possible to apply a black top coating to prevent further direct wear on the concrete and thus extend its life.

The main thing to remember is that we can build a road strong enough to carry almost any load but we can't begin to build the necessary mileage if we try to do that, so *we must fix a reasonable standard maximum load and stick to it* until we build a system of roads that will adequately carry the trucks of every manufacturer, merchant and farmer who wants that service, as well as providing for the convenient carriage of pleasure cars of all classes.

Florida, N. Y., F. R. QUACKENBUSH,
March 12, 1924. Civil Engineer and Surveyor.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

As the **Bureau of Reclamation** has advised the Federal Power Commission that it has no further objection to the issuance of a preliminary permit to the Idaho Power Co. for its proposed development at Twin Falls, Idaho, it is expected that the permit will be granted in the near future.

To Supply Rock for a 12-Mile breakwater along the southern shores of Great Salt Lake, the Western Pacific R.R. plans to blow off the whole face of a cliff 150 ft. high and 1,000 ft. long at one blast. It is expected that approximately 150,000 cu.yd. of rock will be brought down by this single operation.

Extension of Tax Exemption for dwellings another year in New York State is recommended by the Commission of Housing and Regional Planning, Clarence S. Stein, chairman, in a report to the Governor and Legislature, and the recommendation has been endorsed by Governor Smith. The recommendation is limited to relatively low-priced dwellings.

A Conference of State Engineers will be called by Commerce Secretary Hoover shortly after April 1 to consider the basic data which have been collected in connection with the survey intended to show the possibilities of electrical interconnection. The data are a compilation of the individual records submitted by the state engineers, together with all of the federal government's information which bears on the subject.

Hearings Have Been Begun before the House Military Affairs Committee on the Capper-Reece bill to direct the Secretary of War to transfer to the Department of Agriculture for distribution through the Bureau of Roads to the states for road-building purposes 2,000 five-ton caterpillar tractors complete with tools and spare parts, 500 ordnance mobile machine-shop units complete with tools and spare parts, and 5,000 motor trucks, of one to five-ton capacity.

Appointment of an Engineer to the Board of Regents of the University of Texas to fill a vacancy is being strongly urged by the Texas Section of the American Society of Civil Engineers. In a letter to the governor of Texas and in a communication to its members the section asks them to urge this appointment, on the ground that the engineering school is one of the strongest branches of the university and its graduates one of the largest factors in the development of the state.

Train-Control Case Reopened

The Interstate Commerce Commission has reopened the case of its train-control order of Jan. 14, 1924, as it affects 41 railroads of the total of 92 included in that order. The roads affected are all small railroads not included in the order of June 13, 1922. The other roads must continue the installations outlined in the orders of June 13, 1922 and Jan. 14, 1924.

Bonding Conference in June

Latest developments indicate that the proposed meeting to discuss the bonding question, with highway officials, representatives of the bonding companies and the A.G.C. as participants, will not be held until sometime during early June. The meeting probably will be held in Washington. Original plans, formed soon after the meeting had been decided upon as a result of discussions of the subject at the Chicago convention of the A.G.C. in January, were that the meeting would be held sooner than now seems possible. Necessity for postponing the important conference arises from the fact that the American Association of State Highway Officials will hold an executive board meeting in Washington early in June and desires to have the bonding meeting closely proximate to that time so that one journey may enable officials who will attend to cover both events.

Los Angeles Bridge Fails

On March 7 a combination through Pratt truss bridge of 130-ft. span, built in 1899, crossing the Arroyo Seco at 26th Ave., Los Angeles, Cal., failed. The timber span dropped under the weight of a single pedestrian and a Ford touring car 40 ft. to the bed of the waterway it crossed. The bridge had been given competent annual inspection for a number of years and defective timbers had been renewed as needed. The bridge was not subjected to heavy traffic, it being on an unpaved street and not traveled by many motor vehicles. The day before it failed the asphalt wearing surface of the bridge had been repaired and an 8-ton roller and a 5-ton asphalt truck had both been on the bridge a good part of the day. In addition, numerous other vehicles had passed back and forth across the bridge while this heavy equipment was working upon it.

When the bridge failed, the web members broke up so badly that it is considered unlikely that cause of failure will be accurately determined, according to recent advices from the city engineer's office. The web members were close enough to the roadway (20 ft. wide) to make them targets of passing trucks, and damage in this manner is considered a possible cause of failure.

Boston Engineers to Withdraw From Engineering Council

By a vote of 328 to 101 the Boston Society of Civil Engineers has voted to withdraw from American Engineering Council, formerly the Federated American Engineering Societies. The vote was taken by letter ballot, and was canvassed on March 19. Ballots were accompanied by statements as to why the society should and should not withdraw from the Council. Arguments in favor of withdrawal included a statement that the local society's activities had been hampered through diversion of the $800 yearly dues that went to the Council; that, though the Council's aims were worthy there appeared no practical way of translating those ideals into realities; that the Council could not be considered truly representative because of the absence of the civil and mining founder societies.

Arguments in opposition to proposed withdrawal included statements that "the alleged faults of the Council are those of immaturity;" that constructive organizations of any sort are built up through sacrifice and not secession; that the engineers' chief claim for increased recognition lies in their ability to organize and administer, a condition hampered through withdrawal; that the Boston Society has a responsibility toward other younger professional groups and that its withdrawal may influence others to leave the Council. The argument against withdrawal also carried a letter from the Council's executive secretary, L. W. Wallace, in which, among other things, he summed up the achievements of the organization in investigation into and action upon public matters affecting the engineer.

Steamer Pushes 180-Ft. Bridge Span Off Piers in Collision

The steam lumber schooner Martha Buehner on March 8, believed to be out of control, missed the channel through the open draw and crashed into a 180-ft. span of the Southern Pacific R.R. bridge across Coos Bay, Ore. The span was struck at the second panel point and pushed entirely off both piers. One end of the span now rests on the old cofferdam around the pier base, while the other end is submerged in 28 ft. of water. The momentum of the steamer carried it up onto the submerged end of the span, whence it was pulled off by tugs at high tide. There was no serious damage either to the steamer or piers or to the adjoining spans, and the bridge was put again in service in three and one-half days. A temporary crossing composed of an open span on trestle was provided.

The steamer is of wooden construction, 193 ft. long, and of 780 gross tons register. The weight of the steel in the wrecked span was about 219 tons.

Ontario Hydro Reproved Mildly in Report

Commission Commends Publicly-Owned Power Generally, but Quotes High Chippawa Cost

Two years ago when the Drury (Farmer-Labor) party was in control of the government of Ontario, Canada, a small commission was appointed to investigate and report on the engineering and economics of the Hydro-Electric Power Commission of Ontario. The commission consisted of W. D. Gregory, M. J. Haney, L. Harris, J. A. Ross and R. R. Ross (the latter the distinguished Montreal engineer) and had for its consulting engineer Walter J. Francis, the president of the Engineering Institute of Canada, who died last month. The report of the commission has just been made to the provincial government of Ontario, a conservative government which succeeded the Drury government last year. The report is very extensive and has not been made available, but an abstract of its findings has been issued by Premier Ferguson. That abstract indicates that the report is generally favorable to Hydro, though it does criticise the extra cost of the Queenston-Chippawa development caused by the rushed construction work of 1921.

Commission's Findings

In general, the principal findings are as follows:

1. The principle of the public ownership of water powers of the province and their development by the people for the people is, in our opinion, fundamentally sound and should be maintained at all hazards in its full integrity.

2. The engineering department of the commission is made up of men of high professional qualifications as engineers, and as such they are serving the commission zealously and efficiently. The various plants of the commission are exceptionally well operated by them.

3. The methods of accounting adopted by the commission are adequate and proper, but there are some details which should be corrected, mainly in the matter of too long deferring of the refunding period, the failure to provide proper sinking funds for the Niagara development.

4. In practically all cases the principal estimates of cost of developments submitted by the commission to the government have been far too low.

5. The entrance of the commission into radial railway lines is unjustifiable.

The investigating commission also finds that the Hydro has frequently exceeded its legal powers and that the government should have more information regarding its operations.

The section on the cost of the Queenston-Chippawa development shows that the first estimate in 1915 provided for 100,000 hp. with a canal capacity of 6,550 sec.-ft. at a cost of something over $10,000,000. This estimate was revised in 1916 and again in 1917 when an estimate of $12,490,000 was submitted. What is known as Estimate No. 2 was submitted in December, 1917, and it provided for an installation of 300,000 hp. with a canal capable of carrying 10,000 sec.-ft. The amount for this was $24,316,000. This is the last detailed estimate made. Subsequent supplementary estimates brought the figure up to a total of about $27,000,000. The investigating commission finds that the 300,000 hp. capacity plant actually cost $64,000,000 or $37,000,000 over the estimate and that the total cost of the 550,000 hp. development, which is now planned, will be $82,483,914. In this total cost there is an unjustifiable excess of $11,800,000 due to the rush schedule to finish the work by the end of 1921. The investigating commission further reports that the primary cause of the excess cost was the failure of the commission to get more construction equipment on the work after it knew that the shovels were giving only about one-third of the work anticipated in the estimate. They suggest that the commission waited too long to start its rush work and that this might have been avoided had they engaged a manager of construction of high qualifications and wide experience, who, under the commission, would have organized a construction department subject to the commission.

House Collapses Just After Being Pronounced Safe

Within ten minutes after a city building inspector had examined the premises and pronounced it safe the home of Mrs. Lillie Jacobs, 4346 Manchester Ave., St. Louis, collapsed. Excavating was in progress for a store building adjoining the Jacobs home and the assumption is that the foundation of the residence was undermined. However, just before the collapse a building inspector examined the work in progress and had passed upon the safety of the Jacobs home.

Corps Favored to Handle River and Harbor Work

A reorganization bill is being whipped into final shape by the congressional committee which has had under consideration proposed changes in the grouping of Federal bureaus and the proposed reassignment of some of the duties of bureaus.

It is understood that the committee has decided to make no transfer of river and harbor work. This is taken to mean that the committee has disapproved the plan of grouping public works functions in the Interior Department.

In deciding to leave the river and harbor work in the Corps of Engineers of the War Department, the committee is thought to have been influenced by the belief that army officers are in a better position to resist the strong pressure brought by communities and other proponents of river and harbor improvements than would be the case with civilian employees.

Fourth New Jersey City Rejects Manager Plan

A proposal to adopt the city-manager enabling act passed by the New Jersey Legislature of 1923 was defeated in Montclair, N. J., on March 11 by a vote of 2,997 to 2,069 out of a total registration of about 9,000. The town has been under the commission plan for the past eight years. Montclair is the fourth town to reject the manager plan since the Enabling Act of 1923 was passed. The previous rejections were by Plainfield, Atlantic Highlands and Deal.

Bridge Contracts Awarded

On March 21 the Delaware River Bridge Joint Commission awarded to the American Bridge Co. contract for the main stiffening trusses and floor girders, the bid being $2,888,000, the largest contract let so far for the structure. At the same time the contract for the cable bands, suspenders and hand ropes was awarded the Keystone State Construction Co. at a price of $404,850. The bids for the suspended structure included the following principal items:

Classification	Estimated Quantities Pounds	American Bridge Co. Unit Price Cents	American Bridge Co. Amount	McClintic, Marshall Co. Unit Cents	McClintic, Marshall Co. Amount	Bethlehem Steel Co. Unit Cents	Bethlehem Steel Co. Amount
Structural Special Steel	11,300,000	8.75	$ 988,750	9.3	$1,050,900	10.47	$1,183,110
Structural Silicon Steel	9,100,000	7.85	714,350	7.7	700,700	8.99	818,090
Structural carbon steel	16,700,000	6.90	1,152,300	6.8	1,135,600	8.10	1,352,700

The bid of the McClintic-Marshall Co. totaled $2,918,610, and that of the Bethlehem Steel Co. $3,393,917.

Would License D.C. Engineers

The Senate Committee on the District of Columbia has received a bill for consideration which would provide for the examination and registration of engineers in the District. The proposed act, introduced March 12, provides for a five-man board of registration. It also exempts from registration besides certain obvious classes, those practicing engineering solely as officers or employees of the United States or the District of Columbia.

North Platte Commission Formed

The North Platte River Commission, recently appointed for the purpose of formulating a contract between the States of Colorado, Nebraska, and Wyoming and the United States, respecting the use and disposition of the waters of the North Platte River, was organized at Washington, D. C., March 20.

State representatives on the commission, all of whom were present, are: Delph E. Carpenter, Colorado; Robert H. Willis, Nebraska; S. G. Hopkins, Wyoming. Judge Stephen B. Davis, solicitor for the Department of Commerce and federal representative on the commission, was elected chairman.

Following a general discussion of the problems to be dealt with the commission adjourned with the understanding that later meetings would be held in the West at which time there would be public hearings at points in the three states concerned.

Board Reports on Boulder Canyon Dam

Select Engineers Emphasize Need for Dealing with Large Number of Problems Jointly

"The most advantageous combination of projects for the logical development of the Colorado River would include a dam, at or near the site chosen by the Bureau of Reclamation for the Boulder reservoir, that will raise the water level to an elevation somewhere between 1,020 and 1,250 ft.," says the report of a Select Board of Engineers which has just reported to Congress on the Colorado River problem. The board comprised Col. Spencer Cosby, Corps of Engineers, U. S. A.; E. B. Debler, Bureau of Reclamation; Col. W. Kelly, Corps of Engineers, U. S. A. and chief engineer, Federal Power Commission; Herman Stabler, U. S. Geological Survey; W. R. Young, Bureau of Reclamation; and F. E. Weymouth, chief engineer, Bureau of Reclamation. In its study of general facts and the statement of the main conclusion above quoted, the board reported unanimously, but separate opinions on certain points were rendered by Col. Kelly and Mr. Stabler.

Emphasis is laid in the report on the necessity of dealing with a number of large problems jointly, in planning for Colorado River development. Flood protection, conservatism of flood water for irrigation, river regulation, and power development are the most important of these problems. Silt deposition also requires consideration.

Mohave Reservoir Studied

For the purposes of flood protection and stream regulation for irrigation of the lower reaches alone, a reservoir at Mohave was given special study, and Col. Kelly concludes that this site has strong advantages. The board, however, points out that this reservoir would drown out 40,000 acres of irrigable land, and if made of sufficient capacity for all flood regulation purposes, would produce so little power that its entire cost would have to be prorated among the lands benefited. The estimates of the board call for a flood-retaining capacity of 8,000,000 to 10,000,000 acre-ft., while Col. Kelly favors a capacity of 4,000,000 acre-ft.; these would produce regulated flows of 40,000 and 80,000 sec.-ft. respectively, the latter figure being considered sufficient by Col. Kelly. The Mohave dam proposed by Col. Kelly would be 160 ft. high and would have a total capacity of 10,000,000 acre-ft., with 4,000,000 of this reserved for flood protection and irrigation; he believes that it might produce 150,000 hp.

According to studies of Mr. Stabler, there has been a period during which the average discharge of the Colorado fell below figures recently reported, thus reducing the irrigation possibilities or requiring larger reserve storage than contemplated in the studies of the reclamation engineers.

Regulation to 40,000 sec.-ft. maximum flood flow in the lower river would solve all regulation and levee problems, according to the engineers of the Bureau of Reclamation. With a reservoir sufficiently large to receive and deposit all the silt brought down by the river, such regulation would solve completely the problems of the lower river. For this regulation a reservoir of 10,000,000 acre-ft. capacity or a reserved capacity of 8,000,000 acre-ft. in a larger reservoir would be adequate.

Development Costs

Estimates by the reclamation engineers show that the power output and repayment possibilities of the Boulder Canyon development would increase with the height of dam up to a dam of 605 ft. height. Heights of dam from 550 to 605 ft. at this location would represent a total development cost (including power plants and transmission lines) of about $110 per horsepower, and power generation costs of less than 4 mills per horsepower-hour.

The cost of a dam at Mohave of 10,000,000 acre-ft. capacity is about $26,000,000, provided that the foundation conditions prove reasonably favorable. A corresponding reservoir can be built at Glen Canyon for about $77,500,000, but this reservoir would not control floods from the large lower tributaries. The same reservoir capacity can be obtained at Boulder Canyon for $28,000,000, and this would take care of silt deposition for a hundred years or more, but it is believed preferable to build the dam to its final height at the beginning, obtaining 34,000,000 acre-ft. storage for $49,500,000. If newly discovered dam sites nearby, at Spencer Canyon and Bridge Canyon, prove satisfactory upon detailed study, the Boulder Canyon dam in Black Canyon might preferably be reduced in height from 605 ft. to 550 ft., and its storage to 26,000,000 acre-ft. The power development in the two cases would be 660,000 and 550,000 continuous hp. or 1,200,000 and 1,000,000 installed hp., at total costs of $131,000,000 and $111,000,000 respectively, or $109 and $111 per horsepower. Further development could then be made at the other two sites. In the judgment of the Reclamation Service engineers, the 605-ft. dam in the Black Canyon location of the Boulder Canyon reservoir, for 34,000,000 acre-ft. storage, is the desirable solution; 8,000,000 acre-ft. capacity at the top of this reservoir would be reserved for flood control at the start. They find that the available market is capable of absorbing the total output of more than 600,000 continuous hp. within a period of seven years after completion of the dam, at a price that will return the entire cost of the development within two or three decades.

Col. Kelly recommends further studies of foundation conditions at Boulder Canyon: "If the Mohave site proves impracticable, further investigation of Black Canyon and Boulder Canyon should be made to determine the best location for the dam, taking into consideration the fact that it should provide only 4,000,000 acre-ft. of flood storage and should be adjusted as to height to fit into the full scheme of development of the river without unnecessary loss of head." He also states that "if the present controversies over the Colorado can be adjusted so as to permit the Federal Power Commission to act on applications now before it, the needed flood control and irrigation storage will be provided by power developments built without financial aid from the United States."

Construction of the All-American canal from the Colorado River intake above the Laguna dam at Yuma, to supply the Imperial Valley irrigation without entering Mexican territory, is also favored in the report of the reclamation engineers, but the subject is not analyzed or reasons given for the recommendation. The Select Board does not make any recommendation on this subject.

Supplementary Report

A supplementary report by the Select Board on the proposal for a mammoth irrigation diversion project in Arizona condemns this project as impracticable and not feasible. The project proposed a diversion of water from the Colorado near Spencer Canyon at elevation 2,000, and a canal and tunnel system several hundred miles to central Arizona, for the irrigation of 3½ million acres of land. A canal of at least 30,000 sec.-ft. capacity would be required, of which "the first 35 or 40 miles would be located in shale along precipitous cliffs and narrow benches within the canyon. Considering the well-known treacherous character of shale when saturated with water, we think it would be necessary to place the entire canyon section of the canal in tunnel," according to the board. The total length of tunnel on the canal line would be over 80 miles, one tunnel alone being 27 miles long. The diversion dam in the Colorado would have to be 900 ft. high above low-water level. The board reports that the operation of a canal system 700 miles long with 500 lines of main canal in rough mountainous country, carrying a river with three times the low-water flow of the Colorado River along canyon walls, rough lava mountain slopes, and across wide detrital washes, involves difficulties hard to visualize. The cost of the project, stated by its promoters as $290,000,000, would probably be far exceeded. The report concludes, "We consider that this project is inadvisable and is not worthy of serious consideration."

Los Angeles City Engineer Opens Branch Offices

Because of the large area covered by the city of Los Angeles, Calif., and the amount of improvement work under way, branch offices of the city's engineering department have been established in outlying districts. Foremen of street maintenance have for some time been stationed in these districts but each one will now be in charge of an engineer who will have authority to handle completely the engineering projects within his territory. He will have the title of assistant engineer and a staff composed of a clerk, stenographer and one of the draftsmen, according to the amount of work involved. Branches have been opened in the Van Nuys, Sawtelle, San Pedro and Wilmington districts and others will be added as the need arises.

Random Lines

Them Were the Days

Banquet at the Twelfth Annual Convention of the American Society of Civil Engineers' St. Louis, May, 1880

From the files of *Engineering News*

Little Neck Clams on the Half Shell
Chablis

Potage
Crême d'Asperges à la comtesse
Consommé à la Reine
Sherry Amontillado

Poisson
Boiled Red Snapper, à la Hollandaise
Sheep's-Head, Sauce Hollandaise
Croquettes de Pommes de Terre
Salmon, Sauce Anchois
Haut Barsac

Warm Entrees
Saddle of Lamb, à la Purée d'Artichauts
Filet de Boeuf au Champignons
Ris de Veau, au Petit Pois
Grenouilles, à la Crapaudine,
Sauce Bearnaise
Pontet Canet

Cold Entrees
Mayonnaise de Volaille,
Jambons Glacés

Vegetables—In Season
Cauliflower, au gratin
Asparagus
Peas, à la Francaise

Hors D'Oeuvres
Spanish Olives, Sliced Tomatoes,
Punch à la Romaine
English Pickles, Chow Chow

Roast
Spring Chicken
Burgundy

Salad
Shrimp Salad
Lettuce Salad
Water Cresses
Champagnes
Mumm's Extra Dry,
Napoleon Cabinet

Dessert
Corbeille de fruits, Strawberries
Charlotte Russe, Assorted Cakes
Champagne Jelly, Lemon Ices in molds
Vanilla Cream in molds
Coffee Cigars Cognac

* * *

To Remember Pi

Sir—Noticing your mention (March 13, p. 466) of Sloan's rhyme to remember "pi," I would suggest that it read as follows:

3 1 4 1 5 9 2
See I have a rhyme assisting my
6 5 3 5 9
feeble brain its tasks resisting.

This contains neither mathematical nor grammatical errors. G. N. L.

* * *

Two acoustical engineers representing Cleveland, Ohio, companies appeared at the court house Wednesday for an interview with the county court. Business of the court, however, did not allow time for the interviews. Court officials stated that the subject would be taken up for consideration at some future meeting. — Huntington, W. Va., *Advertiser*.

Kentucky Passes Large Bond Issue

The $75,000,000 bond issue bill, which includes $50,000,000 for state highways, has been signed by the governor of Kentucky. The bill will be presented to the people for a vote at the November election this year. The other $25,000,000 is for educational, penal and charitable institutions.

Contract Let on Robert St. Bridge

Contract for the construction of the Robert St. bridge across the Mississippi River has been let by Ramsay County and the city of St. Paul to the Fegles Construction Co., of Minneapolis, the low one of the only two bidders who submitted bids as noted in *Engineering News-Record* March 13, p. 464. Public demand for immediate construction of the bridge overruled any disposition the city and county officers had to issue another call for bids in the hope that the low bid would at least meet the appropriation, the low bid as accepted exceeding the appropriation of $1,500,000 for the structure by $121,310.

As the bid accepted was for construction of the bridge without maintenance of traffic, a temporary structure, the cost of which it is hoped can be held to $100,000, will have to be provided.

Engineers Laud Dismissal of War Fraud Indictments

At a recent meeting the Engineering Association of Nashville, Tenn., adopted a special committee report embodying resolutions commending the action of Justice Hoehling, of the District of Columbia Supreme Court, in dismissing the indictments against Benedict Crowell and six others for alleged fraud in distribution of contracts for cantonment construction. In order that news of the judge's favorable action might be as widespread among professional men as possible, the Nashville engineers have sent copies of their resolutions to all engineering societies, to numerous publications, the State Bar Association, and members of Congress from Tennessee.

Reaction Turbine for 857-Ft. Head to be in Service in July

Construction is progressing rapidly at the Oak Grove plant of the Portland Railway, Light & Power Co. (Oregon) where the 30,000-hp. reaction turbine which is to operate under a head of 857 ft. is being installed. A report made on Mar. 15 stated that on that date the penstock was 50 per cent completed, forms had been removed from the power house and the assembly of hydraulic and electric equipment was actively under way with expectation that the unit would be complete and ready for service in July. The 6-mile pipe line from diversion dam to penstock was to be completed Apr. 1 and on that date concreting of the two short tunnels was to be begun. A picture of this unit, which holds the high-head record for turbines, appeared in *Engineering News-Record* Feb. 7, 1924, p. 259.

Engineering Societies

Calendar

Annual Meetings

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Sixteenth Conference, Los Angeles, Calif., April 7-10, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Atlanta, Ga., April 9-12, 1924.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 13-15, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-24, 1924.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Meeting, San Francisco, Calif., June 11-13, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Convention, June 18-20, Pasadena, Calif.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 23-28, 1924.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, Boulder, Colo., June 25-28.

The Vermont Society of Engineers held its annual meeting in Burlington March 12. The president, Ex.-Gov. James Hartness, and L. W. Wallace, executive secretary of the American Engineering Council, were among the guests. The following officers were elected: president, Prof. L. E. Dix, Norwich University, Northfield; vice-presidents, Prof. P. N. Sweet, Middlebury College, Middlebury, and Prof. E. Robinson, University of Vermont, Burlington; secretary, Prof. A. E. Winslow, Norwich University; treasurer, R. S. Currier, Montpelier.

The Western Society of Engineers has nominated for officers for the coming year: president, E. T. Howson, western editor, *Railway Age;* vice-chairmen, Homer E. Niesz, F. E. Morrow and Major Rufus W. Putnam; treasurer, George W. Hand; trustee for three years, F. F. Cauley; members of Washington Award for three years, Andrews Allen and Paul A. Westburg. Additional nominations by petition may be made before April 20.

Personal Notes

ARTHUR SURVEYER, Montreal, of Arthur Surveyer & Co., consulting engineers, and senior vice-president of the Engineering Institute of Canada, succeeded the late Walter J. Francis as president of the Engineering Institute of Canada, at a special meeting of the Council, March 14. Mr. Surveyer was in the Public Works Department of Canada from 1904 to 1911, acting as assistant engineer on the

Georgian Bay Ship Canal survey, reporting on projects to develop hydro-electric power from the St. Lawrence River and a project to dam the river, and supervising construction of the Port Arthur dry dock and shipbuilding plant. Since 1911 he has been in private practice, but for the government has served as a member of the St. Lawrence River Commission, as consultant on the Chicago Drainage Canal diversion and on several matters pertaining to bond issues.

LOWELL GROSSMAN, former state commissioner of highways of New York, and recently demoted by Col. Frederick Stuart Greene, commissioner of public works of New York State, to his previous position as assistant engineer in the highways bureau, has resigned from the latter position and also declined Col. Greene's offer of appointment as provisional division engineer of the state highway department with headquarters at Poughkeepsie, his home city.

EARL I. ROBERTS, for seven years assistant sanitary engineer in the Ohio Department of Health, specializing in water purification, has resigned to enter private practice, associated with William G. Clark, Toledo. The firm will serve as consulting engineer in waterworks, sewerage and sewage disposal, but will specialize in water purification.

CARL KLAPP, water superintendent of Everett, Wash., for eight years, has resigned to enter private practice as a hydraulic engineer. Mr. Klapp built the big Sultan pipe line, Everett's water supply, and designed plans for the city's new 20-m.g. water reservoir recently completed.

E. C. ANDERSON, structural engineer in the Seattle building department for the past three years, has resigned to enter the office of Henry Bittman, architect and engineer. Previous to his connection with the city, Mr. Anderson was associated with the Oregon Highway Commission and the King County (Wash.) engineer's office.

WARREN D. SPANGLER, INC., consulting engineers, Cleveland, Ohio., have removed their office from the Hanna Bldg. to the Union Trust Company Bldg. and have consolidated their general offices and drafting rooms at the latter office.

F. W. SAWTELLE, Madison, Wis., has been appointed county engineer of Dane County, Wisconsin.

KARL A. LEFREN, formerly chief engineer of the Robert Gair Co., has opened a consulting engineering office at 171 Madison Avenue, New York City, where he will engage in the practice of engineering in connection with power, paper mills, and general mill construction.

E. E. FOSTER, for a year and a half district superintendent of the state highway department, with offices at Columbus, Ind., has resigned.

J. M. PAGE, recently with the U. S. Bureau of Roads at Ft. Worth, Texas, in charge of federal-aid projects in the eastern part of the state, assumed office March 17 as state highway engineer of Oklahoma. Mr. Page has been superintendent of construction and division engineer of the Maryland State Roads Commission, division engineer for the Delaware Highway Commission, county engineer of Campbell County, Va., and later with the U. S. Bureau of Roads.

EDWIN H. ROGERS was elected president of the Boston Society of Civil Engineers at the annual meeting, March 19. Mr. Rogers is chief engineer of the Division of Metropolitan Planning of the Commonwealth of Massachusetts and formerly was city engineer of Newton, Mass.

ROBERT H. ERLEY, who for the past five years has been village engineer of Grosse Pointe Farms, Mich., has been appointed superintendent of public works at Dearborn, Mich. He is a graduate of the University of Michigan and a registered civil engineer in Michigan. He will be in charge of the rapid municipal construction program now under way at Dearborn which has become necessary, mainly, by reason of the expansion plans of the Ford industries.

THOMAS W. HARVIE, heretofore chief engineer of the Montreal Harbor Board, has been made general manager of the board. PAUL LECLAIRE, formerly assistant chief engineer, becomes chief engineer. M. P. Fennell, formerly general manager and secretary, takes a new post created by the commissioners, that of director of trade and transportation, and THOMAS F. TRIHEY has advanced from assistant secretary of the board to the position of secretary.

THE TERRELL BARTLETT ENGINEERS, INC., is the new name of the firm of The Terrell Bartlett Engineers of San Antonio, Tex., which has been reorganized and incorporated and has headquarters in the Calcasieu Bldg., San Antonio. Terrell Bartlett, owner of the old firm, is president of the new firm. The other members are John S. Fenner and Uel Stephens, both former associates of Mr. Bartlett, and Walter E. Dickerson, formerly county engineer of Coleman County, Texas. The firm specializes in hydro-electric development, irrigation, and municipal and highway improvement.

B. E. HAYDEN has been transferred from being project manager of the Belle Fourche project, in South Dakota, of the U. S. Bureau of Reclamation, to the Denver office of the bureau, where he assumes the post of industrial agent.

THEODORE CRANE has received the first appointment as associate professor of building construction at Sheffield Scientific School of Yale, and will have charge of this work which is known as the Thompson-Starrett Foundation, established by Louis J. Horowitz of the Thompson-Starrett Co. and Mary E. Horowitz. Professor Crane will be a member of the staff of the department of civil engineering. He was graduated from Princeton University in civil engineering in 1908 and subsequently was associated with large building construction firms in New York City. Mr. Crane served in France during the World War as captain of field artillery.

Obituary

CHARLES E. BUCKHAM, former superintendent of road construction for the state of New Hampshire, died recently at Nashua, aged 79 years. Mr. Buckham was born in Sidney, Me.

THOMAS L. DARBY, the engineer who located much of the Denver & Rio Grande R.R. and who did much to promote the mining industries of Colorado and New Mexico, died recently at Louisville, Ky., while on a visit there. Mr. Darby had lived 55 years in Denver.

LIEUTENANT-COMMANDER ROSCOE LEE MARTIN, Civil Engineers Corps, U. S. Navy, stationed at Mare Island, California, died there March 16, aged 35 years. Lt.-Comdr. Martin was graduated from the U. S. Naval Academy in 1912, was transferred to the Corps of Civil Engineers of the Navy in 1915 and took a post graduate course in civil engineering at Rensselaer Polytechnic Institute. After a year at the Navy Yard, New York, he was transferred to the Naval Station, Pearl Harbor, Hawaii in 1917, and in 1919 to Mare Island. From that time until his death he was assistant public works officer of the Mare Island Navy Yard.

H. N. BABCOCK, U. S. civil engineer, principal assistant of the First District at New York City, died March 17 at his home in Pelham Manor, N. Y., at the age of 74 years. Mr. Babcock planned and directed many of the improvements in New York Harbor, including the Ambrose Channel and the Jamaica Bay project. He was a graduate of Rensselaer Polytechnic Institute and after several years practice in civil engineering and a few months at army headquarters in Milwaukee, Wis., he was transferred to the Bureau of Ordnance in Washington.

H. D. MEGARY, managing director of the Consolidated Pneumatic Tool Co., London, England, died March 20. He was born in Philadelphia, April 21, 1888. Following his graduation in 1909 from the University of Pennsylvania, he became affiliated with the Bethlehem Steel Co., remaining with that company until June, 1918, when he became connected with the Chicago Pneumatic Tool Co. as assistant to the president, later being made secretary of the company. In 1921 he was transferred to London to assume the duties of managing director of the English company.

Dr. THOMAS C. MENDENHALL, last member of the first faculty of Ohio State University and chairman of the board of directors of the university, died March 23 at his home in Ravenna, Ohio, at the age of 82 years. Dr. Mendenhall was president of Worcester Polytechnic Institute, Worcester, Mass., five years, and of Rose Polytechnic Institute, Terre Haute, Ind., three years, and superintendent of the U. S. Coast and Geodetic Survey five years; he was also at one time chairman of the Massachusetts State Highway Commission.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Equipment Distributors Should Have Part in Standardization Plans

Close Contact with Users Gives Their Representatives Accurate Knowledge of the Needs of the Construction Field

By K. B. Noble

President, K. B. Noble Co., Hartford, Conn., and Past-President, Associated Equipment Distributors

IN THE plans for standardizing construction equipment, outlined in *Engineering News-Record* of March 20, p. 509 and previous issues, the sale participants have been the Associated General Contractors and a committee of equipment manufacturers headed by C. E. Bement of the Novo Engine Co. The object of this work is laudable and there is a vital need for a closer adherence to standard forms and standard sizes than has been the practice heretofore. The success of this standardization plan, however, depends upon the co-operation not only of these two branches of the industry but also on that of a third group that has not been consulted. It does not necessarily follow that because the manufacturers, some contractors and possibly a member of the A.S.M.E. have joined efforts that the end sought can be accomplished.

The Distributor's Service

True, a great deal may be done and many important steps may be taken toward the fulfillment of this ideal plan, but can it be a rounded-out, smooth-working plan without the aid of one of the most important branches of the industry, namely, the organized distributor who has, without question, accomplished more toward the improvement of design and the standardization of design than any other branch of the industry, including the experimental departments of the factories themselves. In fact, what standardization has been accomplished to date has not been wholly brought about through the efforts or initiative of the factory or the contractor. It has been through the active equipment distributor, who is today the means of placing upon the market and in the hands of the contractor fully 80 per cent of the total output of the manufacturers of construction equipment.

It has been by their initiative, the investigations of their field engineers, comments and complaints to the manufacturer and through the fact that they have been forced through general circumstances to limit their variety of sizes and styles of different commodities that many forms of standardization have been effected. This has, in turn, been the means of permitting many manufacturers to turn out their product in fewer types and greater numbers, thereby naturally decreasing the production cost and the cost to the consumer, at the same time decreasing the capital investment of the distributor and the overhead of the distributor who ultimately must buy and sell this equipment.

Having a background of 15 years experience in this business of buying and selling millions of dollars worth of equipment and machinery I can point with some confidence to innumerable and specific cases of where our concern and many others whose policies I know have deliberately selected and purchased only certain models of a given manufacturer, introducing them and really enforcing their sale by reducing the selectivity of a line. As an example, I might cite the hand shovel. Not long ago it was the custom of the distributor to carry at least three, and sometimes four, different brands (meaning quality) and not infrequently three different sizes, Nos. 2, 3 and 4. Today we standardize on one quality, an all-around, finely made, reliable shovel and we cut our sizes down to Nos. 2 and 3. The same initiative has been carried through by the distributor concerning wheelbarrows. We have limited our stock to certain salable, practical models, not over four in number, and have through this step introduced and placed on the market a large quantity of this limited type.

> The claim of the Associated Equipment Distributors to recognition in the equipment standardization program, discussed by Mr. Noble in the accompanying article, is based on the fact that their purchases of stock to sell to the construction industry total about $40,000,000 a year, according to a statement from Morton R. Hunter, of the Hunter Machinery Co., Milwaukee, secretary of the association.

What has been the natural result of this and many other similar instances? The manufacturer frequently finds a falling off in demand for certain models, and erroneously imagines that these particular models are not liked by the trade or have not been in demand. The answer, however, frequently unknown to the manufacturer, has not been field conditions but has meant that the distributor, in self-defense and for the benefit of the entire industry, has been building up a large business on certain limited numbers of models and sizes, thus reducing the large stock which is unnecessary and uncalled for.

This all means that the distributor has, through his knowledge of field conditions, influenced these limitations. This brief illustration will indicate fully that the distributor is not only competent to judge on standardization but has been the principal judge in years past and in my opinion will continue to be, to a large extent, called upon to constructively work with this equipment standardization committee. We have followed the constant improvements that are being made in equipment and would say that, aside from radical designs, full 50 per cent of the basic improvements that have been made in all classes of construction equipment have originated with the field engineer of the distributor, who servicing the equipment he sells, has frequently been obliged practically to force manufacturers to alter designs and models to conform to prevalent ideas and to more efficient operation, service and maintenance in the field.

Contact with All Groups

I believe that there can be no group of men who are more vitally interested in the working out of this proposed standardization plan than the distributors themselves and no one, surely, could be in closer touch with the needs and requirements in the field than the distributors' sales engineers, whose perspective is far broader than that of a single group of contractors because their business is carried on, not with one group but with the entire group, from road builders to mason contractors. The requirements of one group are totally different from the requirements of the other. The standardization of concrete mixers, if too strongly influenced by one group of the contracting industry, such as the road builders would be detrimental to the interests of the builder, whose proportions are totally different and who requires a mixer not only for concrete but also for mortar.

I can well recollect, ten years ago, the condition of the concrete mixer field in which it was the endeavor of each manufacturer to outdo the other and to bring out each successive year a new model of 1-ft. greater capacity than the previous year. The fallacy of this idea has been proved and to-day we can bid on a 4-S or a 7-S mixer in the building line, which is proof that the evolution of this standardization plan has been a success. It will be a greater success by injecting into this settlement the ideas of the organization of distributors who will have to buy this equipment after it is standardized. The success of the standardization plan will depend upon the willingness of the distributor to purchase this stock that has been standardized and the system must be flexible enough to permit a deviation from any one fixed size or style so that it will be applicable to many fields of sale.

I can concerve of a difficulty in attempting to lay down three or four sizes of wheelbarrows and there are other conditions, such as struck level

Forged Tool Varieties Reduced

Washington Correspondence

Styles and sizes of forged tools are to be reduced from 549 to 365, as a result of a conference held recently in Washington under the auspices of the Division of Simplified Practice of the Department of Commerce. The agreement, which has been signed by the manufacturers of 90 per cent of these tools, will become effective July 1. The action affects principally the tools used in railroad construction, building, mining, quarrying, lumbering and blacksmithing. The eliminations were in the following groups: Picks, mattocks and hoes; crowbars, other bars and wedges; sledges and heavy hammers; anvil and blacksmith tools.

The Forged Tool Society was represented at the conference by W. H. Hayes and G. D. McIlvaine, its president and secretary. H. P. Sheets, of Indianapolis, stated that he represented 23,000 retail hardware dealers. The American Railway Association was represented by E. W. Thornby; the Southern Hardware Jobbers Association by John Donnan; the Associated General Contractors of America by C. S. Embrey; the American Engineering Standards Committee by D. R. Harper.

(*Concluded from p. 548*)

measurement, which in many states and municipalities is a fixed rule, as for instance for sidewalk work. I am not commenting on the benefits of this particular regulation but it is an issue that must be considered along with the general standardization of the wheelbarrow.

Distributors Are Organized

The evolution of all construction equipment is so rapid that the standardization today may not be the standardization of tomorrow and who can foretell or is in more constant touch with the building situation than the distributor? Yet in all of the reports of this standardization committee I fail to notice where the distributors' organization—and there is an association today that in itself represents the largest and most responsible distributors of the United States—is even mentioned. I refer to the Associated Equipment Distributors. There is hardly an organization among the established distributors which does not employ one or two graduate mechanical or civil engineers. These men not only have an engineering training but a practical knowledge of field conditions and requirements.

This comment should not be construed as implying in any way that the joint efforts of the A. G. C. and the manufacturers will not accomplish something. My thought is, will not more be accomplished—more in thoroughness, and speed, by bringing into this conference through individuals or the Associated Equipment Distributors a group of men who know every branch and every phase of the general subject of equipment. The contractors' desire for standardization is based on convenience; the manufacturers conception of it relates to production; the distributors' desires are based upon absolute necessity.

Commerce Department Outlines Trade Association Policy

The following statement expresses the attitude of the Department of Commerce in regard to the publication by it of statistics received from trade associations:

The recent correspondence between this Department and the Attorney General relative to the legality of the collection, compilation and distribution by trade associations of statistics or general information has caused widespread discussion and the Department has been frequently asked for a statement as to its policy for the future.

The Department of Commerce will continue to publish its monthly *Survey of Current Business* in connection with which it has been receiving information and statistics from various associations. For the purposes of this and other publications and the performance of other duties imposed upon it by law, the Department will, from time to time, request associations to furnish it with such statistics as may be necessary or convenient for its purposes. The information which associations furnish will be used, within the limits of Department appropriations and facilities, in the publications to the extent that it proves suitable.

The Department is not at present in a position to distribute the information received otherwise than through its publications.

The Department does not express any views as to the legal status of any association from which it receives the information, or any approval of its activities.

Cutting Torch Patents Sustained

A decision rendered Jan. 8 by Judge Learned Hand in the U. S. District Court for the Southern District of New York sustains the contention of the Davis-Bournonville Co. and its successor, Air Reduction Co., Inc., in a suit brought against the Alexander Millburn Co. that cutting torches with tips having a plurality of heating jet passages arranged about a central cutting oxygen jet passage are infringements of U. S. Letters Patent No. 874,666 and No. 1,028,410, owned by Air Reduction Co. These patents cover the arrangement of heating jet passages in a torch tip both with and without provision for the mixing of the heating gases within the tip.

Speaking of patent No. 874,666, owned by Air Reduction Company, Judge Hand said: "It is reasonably clear that the patentees at the time did not recognize the full value of their invention but the fact remains, whether they did or not, that they happened upon a device which became the accepted form, which has displaced all others, and which seems likely to be the final tool by which metals will be cut under this process. As such the patent is entitled to much favor from a court, especially as it appears that for nearly its whole life it has secured the substantial acquiescence of the trade. . . . It took considerable experience and knowledge to see that in metal cutting it was necessary to 'preheat' an area considerably larger than the cut in order to get the metal to the requisite temprature for actual combustion. . . . One cannot make proper cuts with a heating ring, and the division of such a ring into 6 to 8 flames was as much an invention as to multiply Jottrand's single flame. The patent is not indeed a pioneer, but it was apparently final, and stabilized the cutting torch. I cannot see on what theory it can be declared invalid."

With reference to patent No. 1,028,410, also owned by Air Reduction Sales Co., Judge Hand said: "There is no doubt as to the infringement of this patent and that issue requires no discussion. The defendant's tip has merely flattened the cone of the patent upon itself and into a flat surface. Thus the case turns upon validity. There can be no pretense for claiming a broad invention; the disclosure is important only because it enables a quick change of tip for variations in the necessities of the work. Yet there is no reason why, so far as it went, it should not be protected."

Business Notes

Frederick M. Becket, chief metallurgist of the Electro Metallurgical Co., and vice-president of the Union Carbide & Carbon Research Laboratories, Inc. (both subsidiaries of the Union Carbide & Carbon Corporation) was awarded the Perkin Medal of the Society of Chemical Industry on Jan. 11, for his achievements in the field of applied chemistry. Mr. Becket has specialized in electric furnace products, principally the alloy steels. In addition, has been interested in the metallurgical problems connected with welding and cutting by the oxy-acetylene flame, and is directing investigations in this field.

Building Products Co., Toledo, Ohio, dealer in building materials, announces the following changes in its personnel: W. J. Camlin, formerly in charge of the Columbus office, has been appointed manager of the Blaw-Knox steel floor form department of The Building Products Co. at Toledo. M. R. Hausman, formerly territory manager at Toledo, has become branch manager for the company at Columbus. A. A. Frazer, formerly district manager of the J. G. Wilson Corporation in Cleveland, has been appointed territory manager for The Building Products Co. at Toledo. Karl C. Miller, formerly engineer for the Corrugated Bar Co., has been appointed designing engineer, and E. Jean Guardia, former designer and checker for the Kalman Steel Co., enters the company's engineering department at Toledo.

Link-Belt Co., Chicago, as the result of placing its Cub portable loader on a production basis, announces a reduction in price of this equipment to $485. The initial price was $700, followed by successive cuts to $585 and $550. The conveyor is operated by a 60-cycle electric motor.

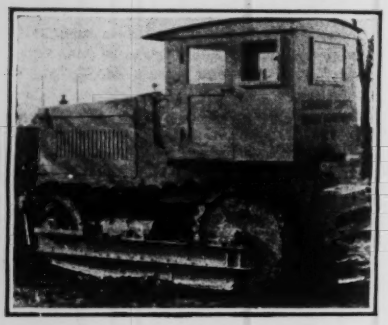
Ingot Iron Railway Products Co., with central offices in the Peoples Gas Building, Chicago, has been organized

for the development and promotion of sales of Armco corrugated metal culverts in the railway field.

Equipment and Materials

New Tractor Has Improved Features

Increased weight, greater tractive power, and stronger parts are among the improvements incorporated in the design of the new model 22 tractor manufactured by the J. T. Tractor Co., Cleveland. The power equipment consists of a Climax engine of larger capacity and slower speed than the Chief motor previously used. In the new model the front wheels are supported in a heavy cast steel yoke, which



can move in guides fastened to the side truck members. This yoke is held in forward position by a heavy spring which keeps a constant tension on the track and allows enough movement to prevent undue strain in case foreign substances pass around the wheel under the track shoes. The rear wheels are fitted with demountable sprockets, fitted with teeth of a shape designed to prevent climbing.

High carbon steel, heat-treated, is the material used for the demountable sprockets, track shoes and track rollers to give increased wear. Hardened steel bushings and pins add to the durability of the track shoes.

A greater drawbar pull is available in the new model. The drawbar itself is made of extra heavy pipe, spring-mounted and supported by a yoke held in position by pins. For winter operation an inclosed cab can be furnished and heated by the exhaust from the engine. A winch has been designed for attachment to the rear of the machine for use in lumbering and hoisting operations; it is made with several different sizes of drums and speeds.

Anchors for Transmission Towers

To reduce the cost of installation and increase the strength of steel transmission towers, a new form of anchor has been devised by A. W. Malone and is being marketed by the Blaw-Knox Co., Pittsburgh. To form the anchor, a hole 4 or 5 in. in diameter is bored, with an auger in earth or a drill in rock. At the bottom of this hole a cavity is formed by exploding a charge of dynamite. The stub angle which engages the post angle of the tower is then lowered into the hole and grouted.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Letting of Water-Works Contracts Gaining In Middle Atlantic and Western States

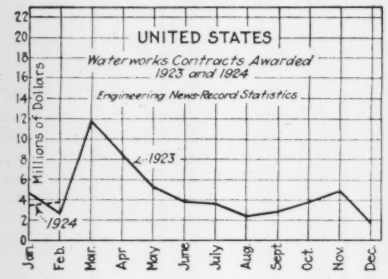
Engineering News-Record statistics compiled on water-works contracts of $15,000 and over show that the year 1923 completed a larger money value of awarded contracts than any of the seven preceding years. The awards were also more than two and a half times as heavy as for the year 1913.

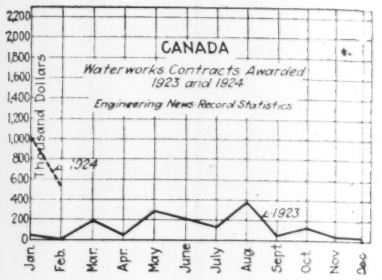
The charts show that the construction of water-works varies with the section and the time of year. The peak of water-works construction for the United States during 1923 came in March with a smaller one in November. This is due to the heavy awards made in the various sections during these periods as shown by the graphs.

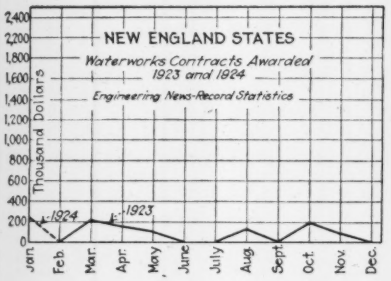
The following table shows the years and the increase of money value in total awards:

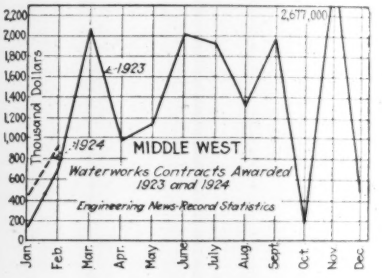
Year	Value
1913	$24,373,000
1917	27,391,000
1918	12,719,000
1919	19,262,000
1920	30,772,000
1921	40,603,000
1922	36,220,000
1923	62,518,000
1924 (Incl. Mar. 21)	10,093,000

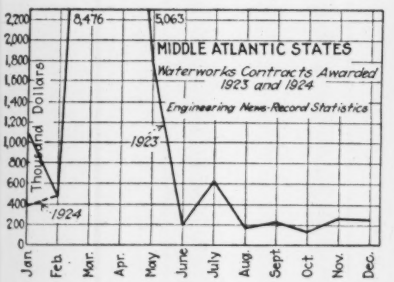
According to geographic sections the water-works construction for 1923 and 1924 (up to and including March 21)

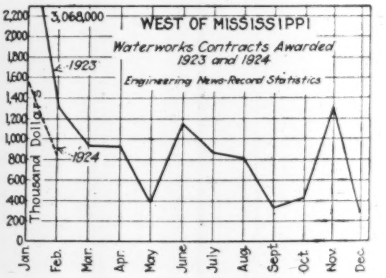


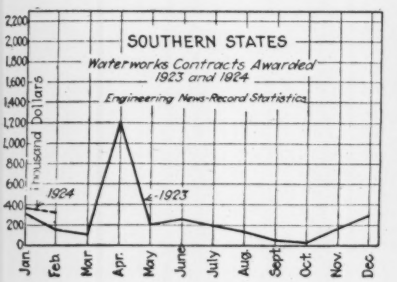


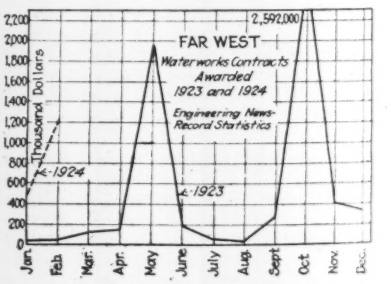












is noted in the following tabulation of money values:

	1923	1924 (Incl Mar. 21)
New England	$947,000	329,000
Middle Atlantic	21,420,000	1,527,000
Southern	3,208,000	960,000
Middle West	17,626,000	2,066,000
West of Mississippi	12,668,000	2,911,000
Far West	6,829,000	2,300,000

The 1924 trend of this type of construction may be noted by the following data. Since the first of the year the amount of proposed work totals $22,549,000 while the value of contracts awarded reaches $10,093,000. This shows that 44.7 per cent of the proposed work so far (including March 21) has gone into actual contracts.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for in Construction News, pp. 171 to 186, are the following:

Filtration Plant additions, Springfield, Mass., $500,000. Expansion of water supply service, $4,000,000.

Bank and Office, Buffalo, N. Y., Liberty Bank, $2,000,000.

High School, Denver, Colo., Bd. of Education, $1,700,000.

Paving, Chicago, Ill. By the city, $1,500,000.

Arsenal, Brooklyn, N. Y., Adjutant General, $1,350,000.

Improving Water-works, Racine, Wis. First unit, $150,000.

Filter Plant, Brazil, Forteleaza, Clara to C. A. D. Bayley, New Orleans, La., $1,500,000. Equipment to International Filter Co., Chicago, $27,000.

Office and Loft, Cincinnati, O., to Ohio Building & Constr. Co., $1,250,000.

Raising grade, Galveston, Tex., to United Dredging Co., $1,120,434.

Museum, Newark, N. J., to George A. Fuller, $600,000.

Bridge, St. Anne de Bellevue, Que., to Dominion Bridge Co., $123,500, to Dufresne Constr. Co., $294,492.

Business Briefs

Call money rate was held at 3 per cent, March 24.

Time money dull with rates as follows: 4 per cent for 36 days; 4¼ for 90 days; 4½ for periods longer than 90 days.

Commercial paper remained at 4½@4¾ per cent.

Foreign exchange: Sterling, $4.29¾; week ago, $4.28¼; year ago, $4.69. France, $0.0535½; week ago, $0.0494; year ago, $0.0661. Lira, $0.0430½; week ago, $0.0425½; year ago, $0.0490½.

Recent Unit Bids From Large Contracts

Acquaintance with construction cost in various parts of the country may be had by studying the unit prices in awarded contracts published weekly in the Construction News section of *Engineering News-Record*.

The accompanying tabulation of unit prices of various materials and operations has been compiled from important contracts awarded during the past three weeks.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 171 to 186, are the following:

Club and Hotel, Detroit, Mich., to Everett Winters Co., $3,500,000.

Bridge, Philadelphia, Pa., to Keystone State Constr. Co., $404,850 and to American Bridge Co., $2,888,000.

Hotel, York, Pa., to J. G. White Eng. Corp., $2,500,000.

Grain elevator, Vancouver, B. C., to Pacific Constr. Co., Ltd., $2,500,000.

Lighting Plant, Tecumseh, Kan., by day labor, $2,225,000.

Hospital, Brooklyn, N. Y., to W. L. Crow Constr. Co., $1,700,000.

Bridge, St. Paul, Minn., to Fegles Constr. Co., $1,621,310.

Foreign Projects of Interest to Americans

A number of foreign construction projects which should be of interest to American engineers, contractors and manufacturers have been reported by the United States Department of Commerce. They are noted here, further information being available at the Bureau of Foreign and Domestic Commerce or its district co-operative offices, when a reference number is given.

Japanese reconstruction budget passed. Complete information may be had by American firms. Reference No. Japan 35X-c.

Irrigation and hydro-electric development planned for Spain. It is reported that the Spanish government will make

UNIT PRICES ON IMPORTANT MATERIALS AND OPERATIONS IN RECENTLY AWARDED CONTRACTS

Location	Date of Issue	Size of Job	Unit Bid	Successful Contractor
Water-works				
Red Wing, Minn.	Mar. 20	Excav. for 1 m.g. reservoir	$4,975.00	C. W. Johnson, Red Wing
San Francisco, Calif.	Mar. 20	Constr. of the reservoir	18,638.09	A. G. Rhodes Co., Guthrie Center, Ia.
		18,600 ft. 20 in. c.i. pipe 4 meter lengths	$4.39 ft.	Grinnell Co.
Sewer				
Fremont, Neb.	Mar. 20	38,800 ft. 27 in. conc. sewer pipe	$1.87 lin.ft.	Platte Valley Cement & Tile Mfg. Co.
		3,100 ft. 21 in. conc. sewer pipe	1.30 lin.ft.	
Excavation, etc.				
Grimes, Calif.	Mar. 20	Const. Canal: 66,400 cu.yd. earthwork	$0.23 cu.yd.	J. Phillips, Oakland, Calif.
		3,000 cu.yd.	.20 cu.yd.	
		2,250 cu.yd.	.202 cu.yd.	
		2,800 cu.yd.	.20	
Placerville, Calif.	Mar. 20	6 mi. canal	.75 lin.ft.	Simpson Bros., Sacramento, Calif.
Streets and Roads				
Freehold, N. J.	Mar. 20	2.15 mf. conc. paving	$115,217.00	Jannacone Contg. Co., Belleville, N. J.
Akron, O.	Mar. 20	42,700 sq.ft. 4 in. cement sidewalk	$0.23 sq.ft.	E. H. Rawle, Akron
		11,500 cu.yd. earth excav.	.60 cu.yd.	
		2,400 cu.yd. cinders	1.10 cu.yd.	
Monroe, Wis.	Mar. 20	16,000 cu.yd. earth excav.	.70 cu.yd.	J. F. Icke, Madison, Wis.
		45,480 sq.yd. conc. surface	1.29 sq.yd.	
		11000 cu.yd. earth excav.	.84 cu.yd.	J. O. Legreid, Stoughton, Wis.
		28,600 sq.yd. conc. surface	1.44 sq.yd.	
		6,200 cu.yd. earth excav.	.80 cu.yd.	W. A. Liljequist, Freeport, Ill.
		31,800 sq.yd. conc. surface	1.30 sq.yd.	
		4,300 cu.yd. earth excav.	.70 cu.yd.	E. Kelley, Sun Prairie, Wis.
		13,200 sq.yd. conc. surface	1.59 sq.yd.	
Los Angeles, Calif.	Mar. 20	81,810 sq.ft. asphalt surface	.228 sq.ft.	Griffith Co., Los Angeles
		51,768 sq.ft. conc.	.22 sq.ft.	
		3,119 sq.ft. walks	.21 sq.ft.	
		5,413 sq.ft. gutters	.25 sq.ft.	
Lumber				
Guthrie Centre, Ia.	Mar. 20	172,800 ft. bridge lumber	$37.40 per M.	Standard Bridge Co., Omaha, Nebr.
		6,000 ft. yellow pine piling	.44 per ft.	
Road Oil				
Minneapolis, Minn.	Mar. 20	1,750,000 gal. road oil	$0.0611 per gal.	Roxanna Petroleum Co., St. Louis, Mo.
Independence, Mo.	Mar. 20	2,000,000 gal. road oil	.045 per gal.	Eureka Petroleum Co., Kansas City, Mo.
St. Louis, Mo.	Mar. 20	500,000 gal. road oil	.05 per gal.	R. J. Brown Petroleum Co., St. Louis, Mo.
Asphaltic Cement				
St. Louis, Mo.	Mar. 20	1,200 tons asphaltic cement	$18.20 per ton	New Orleans Refining Co., New Orleans, La.
Culvert Pipe				
Pierre, S. Dak.	Mar. 20	4,472 ft. 15 in. rein. con. culvert pipe	$0.75	Canton Block & Tile Co. Canton, S. Dak.
		12,042.5 ft. 18 in. rein. con. culvert pipe	.98	
		2,035 ft. 24 in. rein. con. culvert pipe	1.36	
		4,175 ft. 15 in. rein. con. culvert pipe	.79	
		12,200 ft. 18 in. rein. con. culvert pipe	1.05	South Dakota Conc. Products Co. Watertown, S. Dak.
		3,620 ft. 24 in. rein. con. culvert pipe	1.46	
		702.5 ft. 30 in. rein. con. culvert pipe	2.07	

material guarantees to assist the venture. Reference No. Spain 35X-e.

Ice making plant proposed in Bucharest, Rumania. A plant with a daily production capacity of 150,000,000 kilos is planned. It is also stated that this project offers an opportunity for the investment of American capital. Reference No. Rumania 35X-a.

New mine installations proposed in Ontario. These developments should be of interest to American manufacturers of mining machinery and equipment. Reference No. 121819.

Railroad construction proposed in Haiti. The Haitian government has recently obligated itself to finance railroad construction to the extent of about $1,500,000. It is planned to commence work with as little delay as possible. Reference No. 121532.

Government Road Construction planned in Panama. About 30 miles of highway will be constructed directly by the National Government of Panama. Reference No. Panama 35X-a.

Chilean port works bids again invited. A recent decree issued by the Chilean government authorizes the expenditure of a sum not exceeding £900,000 for port works at Constitucion. Bids are to close on July 1, 1924. Information in detail, plans and specifications at 734 Customhouse, or Chilean Consulate, 165 Broadway, New York City.

Grain elevator to be constructed in Alberta. The Dominion government plans to invite tenders in the near future for the construction of a government grain elevator, reinforced concrete and electrically equipped, capacity 2,300,000 bushels, cost $1,250,000. It is stated that a favorable opportunity exists for American contractors and equipment. Reference No. 122,889.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Mar. 6; the next, on Apr. 3.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb.	$3.64	$4.00	$4.40	$3.30	$3.55	$4.20	$3.60	—$3.60	$4.20
Structural rivets, 100 lb.	4.40	4.75	4.90	3.75	4.00	5.15	5.00	+4.50	5.00
Reinforcing bars, ¾ in. up, 100 lb.	3.54	3.50	3.38	3.20	3.45	3.85	3.65	—3.50	3.90
Steel pipe, black, 2½ to 6 in. lap, discount	44%	53.2%	43%	47%	55.05%	36%	36.80@49.10%	45%	47.43
Cast-iron pipe, 6 in. and over, ton	61.60@63.60	—54.00	61.00	57.20@60.20	61.50	69.00	60.00	+65.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.20	2.42	2.84	2.61	2.90	2.72
Gravel, ¾ in., cu.yd.	2.00	2.00	2.38	2.00	1.85	1.90	2.15	1.50	1.50
Sand, cu.yd.	1.25	1.40	2.00	2.00	1.25@1.50	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.00	2.00	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	61.00	40.00	+60.22	55.00	42.75@44.00	55.00	36.00	28.00	65.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.65	1.85	1.50	—1.40	2.70	2.10	2.80	9.50
Common brick, delivered, 1,000	23.65	12.00	+13.60	11.00	14.50	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.091	.11	.064	.075	.065	.....	.11	.115
Hollow partition tile 4x12x12, per block	.1179	.091	.11	.....	.....	.065	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.95	1.04	—1.12	.94	1.04	+1.14	1.07	1.15	1.18
Common Labor:									
Common labor, union, hour	.75	.30	.....	.....	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	....	.25	.30@.50	.82½	.50@.55	.35@.50	.50	.62½	.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93½c.; building laborers (pick and shovel men) 75c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.80 for Kelly Island and $1.70 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 97.56). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3-in., $47.43; 6-in. $119.

Weekly Review of the Market

Building materials prices show few changes despite increasing demand. Steel buying, however, is less active in certain items and sharp competition among jobbers has resulted in slightly lower warehouse prices for shapes and bars, particularly in the Western states.

Demand for galvanized wrought-steel pipe is large, while buying of black pipe gradually tapered off as spring approached. Cast-iron pipe, however, advanced $3 per ton in Seattle.

Pine timbers rose sharply in the Dallas market during the week, following a 5 per cent advance at mills; brick also advanced $2 per M., delivered. The price of common brick at New York is $20 per M., wholesale, alongside dock, which quotation prevailed a year ago.

Fluctuations continue in the linseed oil market. A rise of 2c. in Denver and a decline of 3c. per gal. in Dallas were reported simultaneously to *Engineering News-Record*.

The pig-iron market is easier in tone, with demand limited to small tonnages. Quotations on No. 2 f'd'y. iron are nominal at $22.50@$23.50 per ton, Birmingham. The iron and steel scrap market is also softer. Steel prices, f.o.b. Pittsburgh, range from $2.25 to $2.50 per 100 lb. for plates; from $2.30 to $2.50 for shapes and $2.35 to $2.40 for soft steel bars. The reinforcing bar market continues to show improvement despite the softness prevailing in other steel items. Structural steel bookings are lighter than a year ago and about on par with June, 1922.